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Premature Born Infant's Reaction to the Mother's Voice in Comparison to their Reaction to Music - Effect on Heart Rate and Heart Rate Variability -

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PART ONE: **INTRODUCTION**

Chapter one

Prematurity. Mortality and morbidity of premature born infants. Prenatal brain development. A way from intensive care medicine to development-promoting and family-centred care in neonatology

1.1. Prematurity

The length of a normal pregnancy or gestation is considered to be 40 (+/-2) weeks i.e. 280 days from the date of conception. Gestational age of fewer than 37 weeks at birth is considered as prematurity and infants born before 37 (23/24-37) weeks gestation are considered premature.

The birth of a premature baby can be brought on by several different factors, including premature labour; placental abruption, in which the placenta detaches from the uterus; placenta previa, in which the placenta grows too low in the uterus; premature rupture of membranes, in which the amniotic sac is torn, causing the amniotic fluid to leak out; incompetent cervix, in which the opening to the uterus opens too soon; maternal toxaemia, or blood poisoning. While one of these conditions is often the immediate reason for a premature birth, its underlying cause is usually unknown. Prematurity is much more common in multiple pregnancies and for mothers who have a history of miscarriages or who have given birth to a premature infant in the past. One of the few and most important, identifiable causes of prematurity is drug abuse, particularly cocaine, by the mother.

The prevalence of prematurity in the world varies from 6 to 10% of all newborns (please see Appendix 1.1.). In the German population, with something more than 710.000 - 720.000 newborns per year in recent years (2005 – 2002, respectively), approximately 7% of all newborns in 2003 and 9% of all newborns in 2004 were born prematurely. About 2% of all newborns in 2003 and about 2.5% of all newborns in 2004 were born at an age less than 32 gestational weeks. In the state Baden-Württemberg and at the Perinatal Centre University of Heidelberg the absolute number of prematurely born infants also rose over years (Linderkamp 2005a). The increase of premature infants’ number is the result of increasing age of pregnant women (middle age in Germany is 29 years), increasing pressure at the workplace, advances in reproductive medicine and more often applied reproductive medicine procedures as well as advances in intensive medical care of extremely premature babies, who were earlier treated as abortions (Linderkamp 2005b). The growth of premature born population is of great demographic and economic importance especially in conditions of low birth rate and its steady decline over the years.

Advances in medical technology have made it possible even for infants born as young as 23 weeks gestational age (17 weeks premature) to survive. These premature infants, however, are at higher risk for death or serious complications, which include heart defects, respiratory problems, blindness, and brain damage.

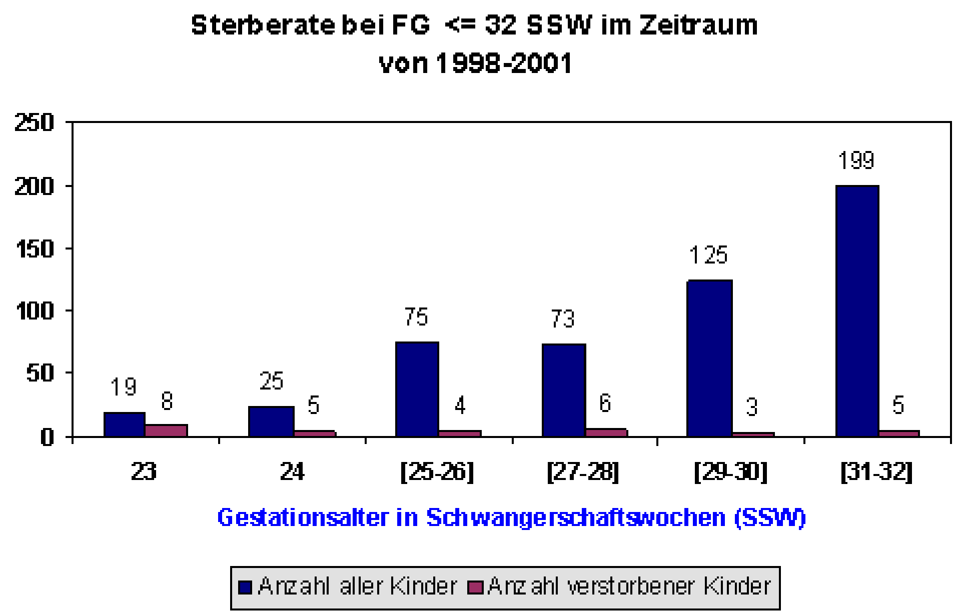
1.2. Mortality and morbidity of premature born infants

Perinatal mortality rate, i.e. infant mortality rate and maternal mortality rate are used by United Nations Children's Fund (UNICEF) as good indicators for the prenatal and perinatal care development in one society. Improvement of the care for the mother and the child and the consequent decrease of these mortality rates is one of the most important goals of UNICEF (UNICEF Innocenti, s. also TransMONEE 2005 Database, UNICEF IRC, Florence).

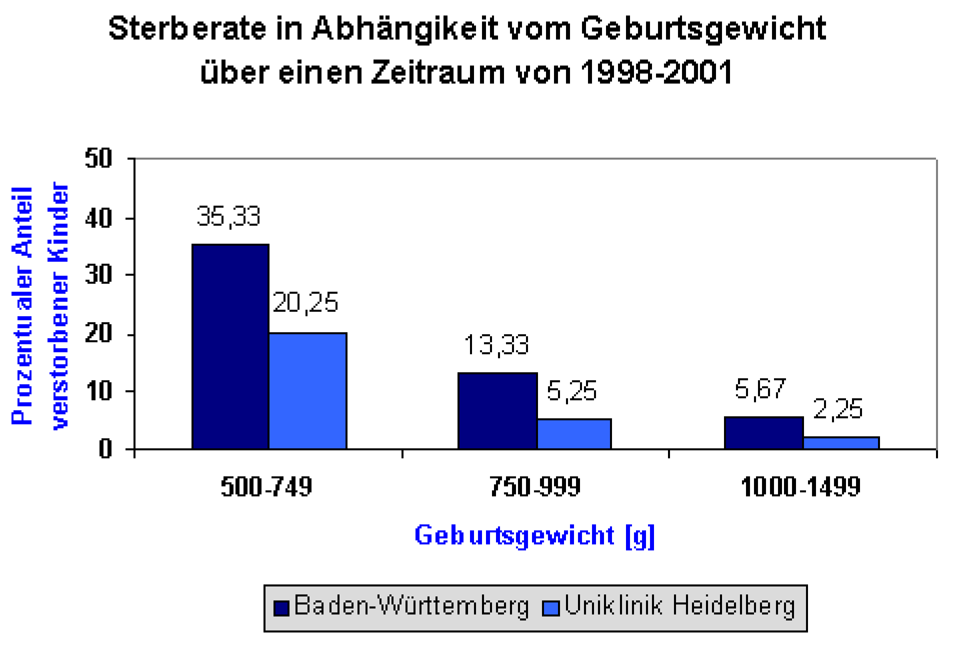
Mortality and morbidity of premature infants contributes substantially to the whole perinatal mortality and morbidity, since prematurity is still the most important risk factor in neonatal mortality. This fact makes the great emphasis that the society places on reduction in premature infant mortality completely comprehensible.

Medical-technical progress in reproductive medicine and in perinatology, particularly in neonatal intensive care medicine in the 70’s and 80’s led to the significant improvement of premature born babies’ mortality. Through the introduction of new medications (surfactant), improvement of techniques (breathing and circulation support, ultrasound) as well as organisational changes (organisation of perinatal centres and specialisation of neonatal medical staff), the lower limit of survivability of premature born infants decreased continuously further and further over the past decades and the prognosis of these very small premature born babies has steadily become better, so that survival rate in developed countries lies nowadays at approximately 85-90% (Westrup et al. 2000). The mortality rate dependent on birth weight and mortality rate dependent on birth age (of less than 32 gestational weeks) at University Children’s Clinic in Heidelberg and in the state Baden-Württemberg are given in the graphics below (Graph 1.1. and Graph 1.2.). The survival rate at University Children's Clinic in Heidelberg lies at 83,33% at the age of 24 gestational weeks.

Graph 1.1 Mortality rate in dependence on birth weight



Graph 1.2 Mortality rate in dependence on birth age



Concerning morbidity of premature born infants, premature babies are mostly born healthy. The diseases of premature period are, therefore, the result of the immaturity of foetal organ systems, which are not yet developed enough and prepared for life outside of the mother's uterus. Typical diseases characteristic for the premature period - respiratory distress syndrome (RDS), bronchopulmonary dysplasia (BPD), necrotising enterocolitis (NEC) or retinopathy of prematurity (retinopathia praematurorum) - occur due to immaturity of lungs, digestion system and the eyes. It may be difficult for a premature infant to regulate body temperature, blood pressure, heart rate (bradicardy) or breathing (apnea). Jaundice as well as inability to breast or bottle feed are also common problems of prematurity. Particularly underdeveloped organ system in premature infants is their nervous system. In addition to immaturity, a premature infant's brain (i.e. also foetal brain) goes through a very dynamic developmental phase, and is, therefore, very vulnerable. Intracerebral and intraventricular haemorrhages as well as periventricular leukomalacia, also characteristic for the premature period, occur due to brain immaturity and vulnerability. The mentioned diseases can damage the structure of a premature baby's organs and impair their function.

The short-term prognosis is, in principle, not poor for premature infants with a gestational age of 24 weeks. However, the long-term prognosis improves only for premature infants born after a gestational age greater than 27 weeks. They remain, nevertheless, at risk for motor disturbances, developmental delay and subsequent intellectual handicaps. It has to be pointed out that even though the medical-technical progress in neonatal intensive care, i.e. support and maintenance of premature infants immature functions has increased the survival rate of younger premature born infants continuously, and the prognosis of these very small premature born babies has steadily become better, the frequency of severe handicaps and developmental disorders stayed proportionally the same (for further information please see the next page). In return, the percentage of premature born children suffering from the so called "New morbidity", i.e. cognitive limitations (for example, memory capacity), partial performance disorders (for example, speaking difficulties), learning disabilities and attention difficulties (for example, attention deficit-/hyperactivity disorder (ADHD)) as well as behaviour disorders, increased significantly (Lorenz 2000).

Infants and children born prematurely do suffer more frequently (up to 50%) than full-term babies from different deficits in neurological long-term development, such as small disorders in sphere of attention, behaviour, motoric control and perceptiveness (Blackman 1991; Cooke 1994; Foulder-Hughes & Cooke 2003).

The Bavarian Longitudinal Study (Wolke et al. 1994; Wolke & Meyer 1999) showed a high prevalence of long-term multiple cognitive problems in very preterm children. Compared to their full-term peers, very preterm children scored significantly lower (approximately –1 SD) on the measures of cognitive and language skills and had major cognitive deficits (less than -2 SD) 10 to 35 times more often than the controls. These persistent cognitive problems appear to be of prenatal and neonatal (treatment) rather than postnatal social origin.

Moreover, an increased prevalence of child and adolescent behavioural problems was observed in former low birth weight infants compared with matched controls both by parents and teachers (Stevenson et al. 1999). Also the attention deficit-/hyperactivity disorder (ADHD) is diagnosed 20-50% more common in premature than in full-term born children (Stjernqvist & Svenningsen 1999).

Despite cultural differences, types of behavioural problems seen in extremely low birth weight (ELBW) children are similar in cross-cultural comparisons (Hille et al. 2001). Learning and school problems investigation in ELBW children in one cross-cultural comparison (Saigal et al. 2003) showed that the proportion of these children who performed within the normal range was as follows: IQ 44%-62%, reading 46%-81%, arithmetic 31%-76% and spelling 39%-65%. More than half of all cohorts required special educational assistance and/or repeated a grade.

A meta-analysis of cognitive and behavioural outcome of school-aged children who were born preterm (Bhutta et al. 2002), performed on cognitive data from 15 studies and behavioural data from 16 studies selected from 227 reviewed studies, showed that children who are born preterm are at risk for reduced cognitive test scores and their immaturity is directly proportional to the mean cognitive scores at school age. This meta-analysis showed also an increased incidence of attention-deficit-/hyperactivity disorder (ADHD) among children born preterm.

A comparison of extremely preterm children with their classroom peers at the time of early school age indicates a great level of cognitive and neurologic impairment. A recent study (Marlow et al. 2005) compared 78% of surviving children, born at 25 or fewer completed weeks of gestation in the United Kingdom and in Ireland in 1995, with their classmates delivered at full-term on cognitive and neurologic assessment at six years of age. Cognitive impairment (defined as results more than 2 SD below mean) was present in 41% of the children born extremely preterm when the results were compared with those of their classmates. The rates of severe disability (indicating dependence on caregivers), moderate disability, and mild disability were 22%, 24%, 34%, respectively. Cerebral palsy was present in 12%. Among children with severe disability at 30 months of age, 86% still had moderate-to-severe disability at 6 years of age. In contrast, other disabilities at the age of 30 months were poorly predictive of developmental problems at six years of age.

1.3. The prenatal human brain development

It is assumed that the cause for this undesired neurodevelopmental outcome are prenatally and perinatally originated disorders in the brain function and structure due to disturbances in the brain development process, i.e. in the process of neuronal network creation and maturation. The human brain development begins already in the early embryonal life (in the 4.-8. week of embryonal life) with organogenesis, when a neural tube, differentiated out of the ectoderm, extends its head part into the brain. The process of morphogenesis is followed by processes of neuronal proliferation, migration, differentiation and myelinisation. Neuronal stem cells proliferate, i.e. multiply rapidly to thousands of millions of neurones. The neurones then migrate to their predetermined target site where further organisation takes part. The processes of proliferation and migration are finished up to the age of 20.-24. gestational weeks, and the cerebral cortex is completely equipped with neuronal cells at this age.

Morphologically, growth and differentiation of neurones lead to considerable enlargement of volume and surface of the cortex. The surface of the cortex, which was smooth (until 24. gestational week), now starts to form gyrus- and sulcus- structure, characteristic for an adult brain (please see Appendix 1.2.).

From the 24. gestational week on, differentiation and specialisation of neurones in the different brain regions as well as myelinisation take place. The neural cell communication is enabled by the chemical mediators – neurotransmitors – responsible for the signal mediation between neurones and for the (concentration dependent) co-determination of neurones differentiation as well as largely increased neuronal conduction speed during myelinisation (Lagercrantz & Ringstedt 1981; Lagercrantz & Herlenius 2002).

Neural cells communicate with each other and form connections between neurone parts called synapses, creating a neuronal network. In the first instance an excess of neural synaptic connections will be produced. Each neuronal cell forms synaptic connection to approximately thousands of other neural cells. A giant neuronal network is created. In further developmental phases, it will be selected which neural cells and which neural synaptic connections are to be preserved. The rest undergoes decline. The selective decline of neural cells and their connections happen through biological programmed cell death – apoptosis (Volpe 1998; 2000a; 2000b; 2001). Approximately half of created synapses will be destroyed through apoptosis in the process of neuronal network maturation.

The famous enormous plasticity of the developing brain will be, thus, determined exactly through this interplay between the formation of neurones and synapses, on one side, and elimination of newly formed neurones and synapses through apoptosis, on the other side. The most important maturation processes the child's brain passes through do happen in this period of life (between 24. and 40. gestational week of foetal life) and during the first months and years of life (Ewing-Cobbs, Prasad et al. 2008; Klingberg 2008). Due to the formation and degradation dynamics in human brain development, particularly this period of life is characterised by the greatest regeneration possibility of the brain.

More important, the formation and degradation of neuronal network occur in permanent exchange with the environment. The neuronal structure changes under the influence of external stimuli, and therefore, this period of brain development is also characterised by the greatest sensitivity of the developing brain and its vulnerability to external disturbance factors (Volpe 1998; 2000a; 2000b; 2001; Kolb, Comeau et al. 2008).

The most important, selection of synapses that remain is experience-based (Lichtman 2001). Optimal environmental influences and experiences are needed for optimal brain development. The importance of the match between the environment and the brain's expectation during "critical" periods of brain development has long been demonstrated in animal models of development, beginning with the classical experiments of Wiesel and Hubel (Wiesel & Hubel 1963a; 1963b; 1965; Mower et al. 1981; 1982; Mower & Duffy 1983; Bourgeois et al. 1989; Rakic et al. 1994).

This phase of the brain maturation in which brain differentiation and myelinisation processes take part, this crucial phase for the formation of the neuronal network that one will be equipped with as an adult, this phase which is characterised by the greatest regeneration possibility, the greatest sensitivity and the greatest vulnerability of the developing brain, takes place from 24. gestational weeks on, which is exactly during the time that a premature born infant spends in the newborn/neonatal intensive care unit (NICU). This is very important to have in mind, since the environmental influences and experiences a premature born infant is exposed to in the NICU differ very much from environmental influences and experiences a foetus is exposed to in the protecting mother's womb.

All the intensive medical environmental influences that differ from the influences in the mother's womb could change this very phase of brain development and could be reflected on the vulnerable developing brain. The stimuli that foetal brain expects in this developmental phase are naturally not available in the intensive care unit. An expected match, between the environment and what the brain needs, lacks due to this deprivation. Furthermore, during (usually long) intensive care treatment, the premature born infants are not only separated from the mother's body and natural stimuli and influences but also (very often) exposed to a variety of unpleasant stimuli, stress factors and pain. And the synapses that are used will be preserved. What influence could these stress factors and the aggressive stimuli of the intensive medical care environment have on the developing immature brain of the premature child? Early experiences in the form of increased stress, pain stimuli and application of barbiturates could accelerate naturally occurring apoptosis and, thus, alter development of the brain regions responsible, for example, for the cognitive and emotional functions, i.e. alter development of the brain regions responsible for the "new morbidity". Enhanced naturally-occurring-neuronal-apoptosis due to lack of social stimulation and multiple metabolic stresses is one of the recently proposed mechanisms that could lead to enhanced neuronal cell death in the immature brain. Another proposed mechanism would be citotoxicity resulting from repetitive or prolonged pain (Bhutta & Anand 2002). The pattern and magnitude of brain development abnormalities would depend on individual genetic variability as well as the timing, intensity, and duration of adverse environmental experiences. Cumulative brain damage during infancy could, thus, lead to reductions in brain volume, abnormal behavioural and neuroendocrine regulation, and poor cognitive outcomes during childhood and adolescence.

Similar to the animal models of development, the infant's sensory experiences in the intensive medical environment, including exposure to bright lights, high sound levels, and frequent noxious interventions, may exert deleterious effects on the immature brain and alter its subsequent development. The latest research in this field demonstrates that early experience alters also human brain function and structure (Als et al. 2004) (for further information please see Chapter 1.4.).

Despite our vast medical knowledge, it is not yet possible to give a reliable prognosis about further neurological development of the high-risk premature born infant (Marlow et al.

2005). Furthermore, already developed disorders and handicaps, however small and early diagnosed, demand a (long-term) rehabilitation treatment, whose application does not always lead to expected improvements, despite all the personal, family, social and economic burdens. The public health and economic importance of preventing or ameliorating the subtle brain damage of the developing premature infant brain can not be overestimated.

For these reasons, an era of increased research interest for the psychological conditions of newborn medical care has started in recent years. In an effort to improve the long-term cognitive and behavioural neurological developmental outcomes of premature born infants, the medical research focuses on searching for and pointing out the connections, according to which adverse experiences and environmental factors of the intensive medical milieu could have effects on the cognitive and behavioural development of premature infants. The emphasis lies on *if* it is possible to improve the long-term neurological prognosis and outcome of these infants and *how* could the change of environmental medical milieu achieve the desired improvement of the neurological developmental outcome of premature born infants. Could this be achieved by minimising the impact of adverse experiences and environmental influences? Or could this be achieved by minimising stress?

Whether certain forms of positive sensory stimulation could compensate the natural stimuli deprivation, soothe the pain and soften the stress effects of the neonatal intensive care and to what extent, as well as whether utilising a tender medical approach in neonatal intensive care and individual-development-promoting care principles could result in more favourable conditions for the brain development of premature born infants is the subject of current research studies in neonatology.

1.4. A way from intensive care medicine to development-promoting and family-centred care in neonatology

As already pointed out, the lower limit of survivability and the survival rate of premature born infants have spectacularly improved over past decades due to the medical-technical progress in neonatal intensive care. Nevertheless, the neurodevelopmental outcome of premature born children remains a cause for grave concern.

This neurological outcome seems to be the result of not optimal brain development, i.e. not optimal environmental influences and experiences needed for optimal brain development in this period of life.

The foetus is, due to the premature birth, separated from its natural (optimal) environment, i.e. optimal natural environmental influences and experiences and suddenly situated and forced to live in the intensive care unit (NICU).

Premature born infants are nowadays, therefore, considered as foetuses in NICU, i.e. as competent foetuses who find themselves too early and unexpectedly in a technological hospital environment instead of the evolutionary promised mother's womb.

A comparison between optimal natural environmental influences and experiences and those in the neonatal intensive care unit may help to illustrate the point:

The sensory experiences one foetus is exposed to in the mother's womb differ very much from those experiences one premature infant is exposed to in the NICU – a parallel can be seen in the Table below:

Table 1.1. Sensory experiences of a foetus in mother's womb and sensory experiences of a premature infant in NICU (according to Linderkamp 2005b, 2005c, 2005a)

Foetus	**Premature infant**
Warmth (37°C), amniotic fluid	Variable temperature, air stream
Tactile – surrounded / enclosed by womb	Tactile - hold tight, bound tight, pain
Spontaneous free movements in amniotic fluid	Position by nursing staff, pet/caress, skin-to-skin contact & care
Darkness - only 2% of daily light (rose coloured)	(Glare) light
Smell – natural, of parents	Smell – hospital disinfectants
Sounds - blood flow, intestinal sounds, mother's voice, mother's heart beat, environment sounds (music, among others)	Sounds - technical sounds, monitor alarms, different voices

An environmental medium a foetus is surrounded by is amniotic fluid, which is constantly warm (37°C). Amniotic fluid enables spontaneous free movements free of force of gravity. In contrast, a premature infant is surrounded by air, whereby each opening and closing of the incubator's door exposes him/her to variable temperature and air stream. A premature born infant's position is determined by the nursing staff and movements are limited by nappy, tubes, sticking plasters, with the force of gravity as an additional burden for already limited movements.

Concerning tactile stimuli, the foetus is enclosed by a womb which surrounds and supports him/her providing, thus, a border and feeling of security, whereby premature infant is free in space or in the best case enclosed by pillows. During medical procedures, a premature infant is held tight, sometimes bound tight or feels pain. In the best case premature infant feels caresses, skin-to-skin contact and care or massage.

The foetus smells natural smells of his/her own parents and tastes the sweetish amniotic fluid. A premature baby smells (and tastes) nursing care products and hospital disinfectants, smells of plastic and metal tubes of numerous medical devices and sometimes perfume or nicotine smell on the hands of caregiving persons.

Concerning light and visual stimulation, the foetus is almost in complete darkness, only 2% of daily light comes to him/her (Goldson 1999) and he/she experiences day-and-night rhythm. In contrast, a premature infant is exposed to the bright hospital lights day and night, and the light becomes even glare (50-200 times higher light intensity than in the uterus) when a medical procedure has to be performed. Bright light can trigger stress reactions such as hypoxia and apnoea as well as raise the risk for the development of retinopathy of prematurity (Seibert et al. 1994).

Sounds that the foetus hears constantly like, for example, mother’s body sounds such intestinal sounds, mother’s heart beat and blood flow are low frequency sounds (< 0,1 kHz) of about 60-90 dB. Sounds that the foetus hears from time to time like the mother’s voice and some environmental sounds like the father’s voice, music or even noise are as high frequency sounds filtrated to a great extent and they reach maximally 40 dB. Sounds that a premature infant steadily hears are high frequency (> 0,2 kHz) technical sounds of different medical devices, monitor alarms as well voices of different less familiar persons (changing medical staff) reaching the noise level of 90 dB and above (which even exceeds the noise level allowed for adults working spaces).

Therefore, apart from providing numerous life-saving methods, the NICU is lacking in important physiological stimuli required for the optimal brain development (deprivation), and moreover, NICU exposes (stimulation overload) the developing premature infant’s brain to the stimuli that may cause severe stress reactions and be responsible for the reported long-term neurological disabilities.

Awareness and acknowledgement of the consequences these differences between uterine environment and NICU environment stimuli can have on neurodevelopmental outcome of premature born infants encouraged efforts to humanise the NICU environment, to change the environmental influences and experiences a premature born infant is exposed to at the neonatal intensive care unit. With an attempt to decrease the discrepancy between the immature brain's expectation and the actual experience in a typical NICU environment, modern neonatal care tend, therefore, to imitate the optimal natural environmental influences and experiences a foetus is exposed to in the mother's uterus as much as possible.

In an endeavour to be more like the mother's womb, modern neonatal care encourages insertion of expected natural positive stimuli in a NICU setting, i.e. encourages efforts to humanise the NICU setting. Any NICU intervention undertaken to improve neurodevelopmental outcome, including NICU design, nursing routines, nursing care plans, management of pain, feeding methods and, most importantly, encouraging parental involvement with their NICU infant is called neurodevelopmental care intervention (Aucott et al. 2002).

This tender approach - the so called "tender care" - entered neonatal intensive medical care in the 90's both through controlled clinical trials (Als et al. 1994) and empirically (Marcovich 1995), and spread gradually over the years so that modern neonatal intensive care units (in developed countries) nowadays very much pay attention to sensory stimuli an infant is exposed to and are equipped according to the "tender care" principles.

First of all, the mentioned adverse environmental stimuli and experiences, the mentioned non-physiological optical, acoustic, olfactory, tactile and vestibular stimuli resulting from the neonatal intensive care unit techniques and the personnel are eliminated or minimised.

Modulating light exposure is, thus, practically, one of the greatest challenges faced by the modern neonatal intensive care units: permanent illumination and bright lights are avoided; light is attenuated during the day and completely switched off over night. Respect for the circadian light/dark cycles and physical activity is also one of neurodevelopmental care interventions human NICU pays attention to. Additionally, incubators are covered with dark sheets or towels, which reduce both light and noise, and equipped with small indirect lights for examination and intervention purposes. Direct light should never fall on the face of an infant.

Reducing noise level and displacing noise with pleasant acoustic stimuli is another very important change in the modern NICU: intensive care unit sounds should be reduced to a possible minimum - loud monitor alarms, other technical devices sounds as well as the noise coming from the personnel should be avoided. Each infant's area should be considered and respected as the sleeping sphere of a very sensitive child. Since a foetus of 33 gestational weeks on can remember and recognise his own mother's voice, her speaking melody and spoken words, parents should be encouraged to speak with their own child, or read or sing to him/her. A calming effect of acoustic stimulation could also come from music (for further details please see Chapter 2).

Concerning tactile stimuli, parents are encouraged very early on to touch their child. Skin-to-skin, i.e. Kangaroo care (described below) is one of the most popular and the most effective tactile stimulation interventions in modern NICU. Also, the medical staff members take up tender touch contact with infants. Special massage programmes are developed for premature born babies.

Vestibular stimulation takes part already before the birth with each mother's body movement and continues after the birth through cradling the baby on the breast and carrying the baby around in their arms or in a pram. The former could be practised with premature babies through Kangaroo care (please see further). Attention to infant positioning (kinaesthetic) is paid.

Concerning position and self-movements promotion, trained and skilled personnel will lie the premature infant down according to his/her current individual needs. Pads and pillows will help to achieve the right positioning. Building up a "nest" will offer enclosure and support for a premature infant. All the materials that are in contact with a premature baby should be soft, friendly to their skin and appropriate in size. Medical devices, tubes, electrodes, cables should disturb the child as little as possible and should not inhibit his freedom of movement. Free movements will enable self-regulation, therefore, an infant should be free to play with his/hers hands and feet and bring them close to the body and mouth.

The second very important intervention spectrum that enables substantial improvement of conditions for an infant's brain development is the so called "minimal handling approach" (Langer 1990). According to this care principle, the environment in the modern NICU is designed to have the least possible disruptive effect on an infant's development, above all by avoiding of unnecessary medical and care activities that produce distress for the infants and their families.

In addition, the numerous unpleasant and painful medical interventions are performed simultaneously with pain management procedures, such as non-nutritive sucking or oral glucose.

Moreover, while the intensive care *per se* is in the modern NICU reduced to the necessary minimum, the devotion to the infants and their parents is increased to the possible maximum, in accordance with the current concept of University Children's Clinic in Heidelberg: "Minimisation of intensive medicine procedures to the absolute necessary and maximisation of care for the child and its family" (Linderkamp 2005c).

Furthermore, lack of stimulation with and deprivation from physiological stimuli and experiences in hospital environment is the third, very important, area of refinement processes in the NICU setting. Therefore, physiological stimuli that promote development are offered, such as maternal voice, parental touch or skin-to-skin contact.

One of the very successful methods to moderate early and unexpected separation of an infant from his/her mother's body, which makes both the child and the parents (even more) insecure (Klaus et al. 1972), is skin-to-skin care or the so called Kangaroo care. Kangaroo care comes originally from Columbia. It was introduced by Dr. Edgar Rey Sanabria in 1978 in one Children's clinic in Bogotá that was overcrowded with premature born infants but able to offer them neither intensive care treatment nor take adequate care of all of them. Mothers were advised to take their babies home and carry them on breasts for days or weeks. Through this intervention babies were supplied with warmth and fed with milk (Doyle 1997). Imported from Columbia, adapted for NICU application and incorporated in the NICU setting, the Kangaroo care became one of the most important care standards in developed countries nowadays.

For these purposes, one bed or deckchair is always near each incubator or infant's bed. The mother or the father of a premature infant is advised to lay down and open her/his blouse or shirt, while the personnel put the premature infant between the mother's breasts or in the middle of the father's chest, naked, skin to skin, and covers it with an artificial fleece piece and then with the parent's clothes. Monitoring electrodes are tightened on the back side of the infant. Parent and infant rest together for several hours. Studies have shown that through this care, the warmth is not lost, the temperature of an infant can even rise 0,5°C, breathing and circulation are more stable (Fischer et al. 1997; 1998). Breast feeding is easier to perform, the whole clinic stay is shorter and associated with less complications (Ludington-Hoe & Golant 1994).

The most important benefit is the change in mothers' perception of her child, attributable to the skin-skin contact ("bonding effect"), which supports and promotes attachment between mother and infant. Mothers practicing kangaroo care blame themselves for the prematurity less and feel more competent (resilience effect) in stressful situations in the NICU (Tessier et al. 1998). The mother-infant relationship is better, less interaction disorders and even less crying at the age of six months was reported in one study.

Enhancement of the parent-infant interaction and parent-infant bonding (please see also Chapter 3) through early body contact, touch and speaking, is also part of modern NICU intervention programmes.

Modern NICU personnel also considers in this way the infants' parents needs and recognises and supports each particular family's strengths. In that way, infants benefit both directly and indirectly, through comfort that the NICU offers their parents.

Above all, the modern NICU is designed to consider a premature infant as an active participant in his/her own care. The personnel is, therefore, trained to understand infant signals and signs of stress and comfort, needs and competences and to structure the caregiving procedure according to these individual needs and wishes. "Reading the premature infant" (Als 1999; Fisher & Als 2003) is, thus, guidance for the very individual care and the individual development promotion of each premature infant. A parallel between the care of premature infants in the past and nowadays can be seen in the following Table (please see the next page):

Table 1.2. Care of premature infants in the past and nowadays (according to Fischer & Als 2003 & Linderkamp 2005a)

Usual care – NICU of the past	**Child-Family-oriented care – Modern NICU**
Protocol-driven	Relationship-driven
Task-driven	Individualised
Personnel as timer	Child's rhythm as timer
(Procedure rhythms of the NICU)	(Organisational course of events driven by the child)
Crisis oriented	Development oriented
Reparation (neonate in deficit)	Promotion of the strengths (competent child)
Treatment/Manipulation of the child	Cooperation, interaction with the child
Technology in centre	Child and Family in centre
Special disciplines for different organs	Person as unity
Based on action	Based on reflexion
NICU as operating room	Environment similar to mother's womb

The culmination of nowadays neonatal care in an effort to decrease the discrepancy between the immature brain's expectation and the actual experience in a typical NICU environment is a comprehensive approach, based on neurobehavioural assessment of an individual premature infant's competences and limits, named *Newborn Individualized Developmental Care and Assessment Program*® (NIDCAP®). It is the assessment of mutually interacting behavioural subsystems in simultaneous interaction with the environment. Infants are understood as actively seeking their next differentiation, while counting on good enough environments to assure progressing developmental competence.

NIDCAP® has been developed by Heidelise Als, a psychologist, who started with the observations of newborn baby behaviour as a member of Brazelton's team. The in neonatology well known examination concept, the Brazelton Neonatal Behavioural Assessment Scale (Brazelton 1973; 1984) was developed by this team in the early 70's. Distinguishing normal from abnormal neonatal behaviour and trying to obtain some prognostic conclusions about long-term development from the behaviour in the newborn period, Als became aware of the enormous influence that intensive medical care does have on the behaviour of full-term and preterm newborn babies. Starting with these observations, the whole concept that should enable an optimal development of each premature infant through an individual care in spite of interfering intensive care treatment influences was developed and patented (Als et al. 1982; 1988a; 1988b).

The NIDCAP® concept was already tested both in the original setting and in other settings and it was shown that the NIDCAP® intervention has numerous positive effects on both somatic and neurological short-term development (such as shorter assisted ventilation and extra-oxygen need, rarer chronic lung disease, rarer brain haemorrhage, faster head circumference growth and better neuropsyhological organisation, shorter probe nourishment, less medical complications, shorter clinic stay and less expenses) and on the long-term developmental outcome of premature infants (better motor and mental development, development of intelligence, better behaviour and mother-child interaction) (Als et al. 1994; 1996; Westrup et al. 1997; 2000; 2002; 2004; Kleberg et al. 2000; 2002).

Very recently, the NIDCAP® concept was tested on neurodevelopmental outcome in a randomised clinical trial. It was shown that early experience alters also human brain function and structure (Als et al. 2004).

In this study the NIDCAP® intervention was applied in thirty premature born infants (28-33 weeks' gestational age), initiated within 72 hours of intensive care unit admission and continued to the age of 2 weeks, corrected for prematurity. The individualised intervention consisted of daily (7 days a week) observations and evaluation of infants' behaviour, with suggestions for parents and staff in terms of ways to support each infant's development. The developmental specialists provided daily contact and support for the caregivers in understanding the experimental group infants' stress and comfort signals, adjusted their care accordingly, and conceptualised the infants as active participants in the care delivered. The developmental specialists used the observations to formulate descriptive neurobehavioural reports and suggestions, to structure caregiving procedures to the infant's sleep/wake cycle, and to maintain the infant's well-regulated behavioural balance in an effort to promote the infant's strengths and simultaneously to reduce the infant's self-regulatory vulnerability.

Infants were assessed at 2 weeks' corrected age on: 1) neurobehavioural outcome – motor system modulation and self-regulation parameters according to APIB & Prechtl (Als et al. 1982; Prechtl 1977), 2) neurophysiological outcome – EEG (electroencephalogram spectral coherence), and 3) neurostructural outcome – MRI (magnetic resonance diffusion tensor imaging). Additionally, at the age of 2 weeks' and 9 months' corrected age, infants were assessed on health status & growth.

The experimental group showed significant improvement in neurobehavioural outcome at 2 weeks' age and continued to show significantly better performance than the control group of children. Neurophysiological outcome was also significantly better in experimental infants versus control infants - EEG coherence measures illustrated how original coherence variables differ between experimental and control infants showing the maximal loadings (correlations) of original coherence variables on the indicated factor in experimental infants. Neurostructural outcome (MRI DTI): diffusion tensor maps from identical axial slices through the frontal lobes of a representative control group and experimental group infant obtained at 2 weeks' corrected age showing anisotropy in white matter. The greater anisotropy of white matter was found in the experimental infant as compared with the control infant at the posterior limbs of the internal capsule and the frontal matter adjacent to the corpus callosum (please see Appendix 1.3.). The greater anisotropy fund in the experimental infant suggests *more advanced white matter development* in these regions as compared with white matter in the control infant.

Thus, this is the first *in vivo* evidence of positive effects of early (postnatal) experience on brain development i.e. of enhanced brain function and structure due to NIDCAP®. This study demonstrates that quality of experience before term may influence brain development significantly.

Neonatal care according to the NIDCAP® principles is becoming more and more popular all over the world and is applied in the NICU in Heidelberg.

Chapter two

Pleasant acoustic stimulation as a possible stress coping tool in neonatal intensive care unit

2.1. Auditory world of premature infants

As mentioned in Chapter One, the auditory world of a premature born infant situated at a newborn intensive care unit (NICU) differs very much from the auditory world any foetus experiences in the uterine environment.

Sounds that a premature infant steadily hears are high frequency (> 0,2 kHz) technical sounds of different medical devices, monitor alarm as well voices of different less familiar persons (changing medical staff) reaching the noise level of 90 dB and above (which even exceeds the noise level allowed for adults working spaces). The foetus, in contrast, constantly hears the mother's body sounds such as intestinal sounds, mother's heart beat and blood flow which are low frequency sounds (< 0,1 kHz) of about 60-90 dB. Occasionally, a foetus hears the mother's voice and some environmental sounds present in her usual surroundings as well (father's voice for example, or music, or even noise) whereby high frequency sounds are filtrated to a great extent and they reach maximally 40 dB. Thus, the sounds available to foetus *in utero* are dominated by low-frequency energy, whereas energy above 0,5 kHz is attenuated by 40 to 50 dB (Gerhardt & Abrams 1996; 2000).

Increased survival of very low birth weight infants including those born at the cutting edge of viability is associated with substantial cognitive and behavioural deficits at follow-up that extends into school age and adolescence. Factors/events that may predispose these problems include medical complications of prematurity, medications used to treat such conditions and stress associated with prolonged hospitalisation. Being connected to multiple devices that limit interaction between infant and caregiver, high noise level and constant light levels are also considered to be of particular importance for the development of such deficits.

Experimental evidence that demonstrates the value of positive interactions between an infant and his/her caregiver with regard to neurobehavioural outcome is rising. Therefore, some suggested NICU interventions, proposed for the better developmental outcome, include not only reducing noise levels, displacing it with music and modulating light exposure but also enhancing infant-parent interaction interventions, such as Kangaroo care (Perlman 2003).

Aversive environmental auditory stimuli as well as level of noise that premature infants are subjected to are a common concern in neonatal intensive care. The purpose of auditory stimulation application in the NICU is, therefore, to overcome the existing noise due to technical sounds and to compensate for the lack of natural intrauterine acoustic stimuli. Auditory stimulation attempts also to alleviate the infants' stress due to stress eliciting events in the NICU as well as to support infants' developing stress coping strategies.

Therefore, one of the most important changes that modern NICU has at its disposal in comparison to the NICU of the past is noise level reduction and displacement of noise with pleasant acoustic stimulation. Intensive care unit sounds are reduced to a possible minimum - loud monitor alarms, other technical devices sounds as well as the noise coming from the personnel are avoided. Each infant's area is considered and respected as the sleeping sphere of a very sensitive child (Linderkamp 2005a).

The literature regarding the effect of sound on the foetus, newborn and preterm infant was reviewed by a multidisciplinary group of clinicians and researchers, and the following recommendations for auditory stimulation of the developing infant were given (Graven 2000):

1) Women should avoid prolonged exposure to low-frequency sound levels (<250 Hz) above 65 dB (A) during pregnancy;
2) Earphones or other devices for sound production should not be used directly attached to the pregnant woman's abdomen;
3) The voice of the mother during normal daily activities, along with sounds produced by her body and those present in her usual surroundings, is sufficient for normal foetal auditory development. The foetus does not require supplemental stimulation. Programs to supplement the foetal auditory experience cannot be recommended;
4) Infant intensive care units should incorporate a system of regular noise assessment;
5) Sound limit recommendations are to maintain a nursery with an hourly Leq of 50 dB (A), an hourly L10 of 55 dB (A) and a 1-second Lmax of 70 dB (A), all A-weighted, slow response scale;
6) Infant intensive care units should develop and maintain a program of noise control and abatement in order to operate within the recommended permissible noise criteria;
7) Care practices must provide ample opportunity for the infant to hear his/her parent's voices live in interaction between the parent and the infant at the bedside;

8) Earphones and other devices attached to the infant's ears for sound transmission should not be used at any time;

9) There is little evidence to support the use of recorded music or speech in the environment of the high-risk infant. Audio recordings should not be used routinely or left unattended in the environment of the high-risk infant.

These recommendations, if followed, should provide an environment that will protect sleep, support stable vital signs, improve speech intelligibility for the infant, and reduce potential adverse effects on auditory development.

The "Heidelberger attitude" (Linderkamp 2005a) recommends a sound intensity of approximately 40 – 50 dB for the acoustic stimulation in the NICU, in any case lower than 60 dB, in order not to exceed 75 dB due to additional loudness.

2.2. Music and music therapy - beneficial effects of music

Sound is caused by vibration/oscillation. Periodic, more complex vibrations, such as those produced by musical instruments and/or the human voice, produce harmonics which are perceived as pleasant, preferred sound. When the sound-wave pattern of periodic complex vibrations is sinusoid, the sound is musical. In other words, music is sound characterised by smooth, regular sinusoid sound-wave pattern of periodic complex vibrations/oscillations, whereas noise, on the contrary, is characterised by irregular sound-wave pattern. Due to this regularity, music is, acoustically, much more pleasant, soothing and interesting than noise.

Music therapy is an intentional use of music to improve physical, psychological, cognitive, and social functioning. In the form of therapy, music is used as a non-pharmacological intervention in a variety of areas of clinical practice as an additional treatment in order to improve patients outcomes. It is an easy-to-administer, relatively inexpensive, non-invasive intervention that has been used in patients experiencing health problems due to stress in order to reduce heart rate, blood pressure, myocardial oxygen consumption, gastrointestinal function, anxiety and pain (White 2001).

Studies on music therapy suggest that music therapy can be an effective nursing intervention in stressful situations for decreasing anxiety, blood pressure and heart rate, and may be, therefore, useful in a wide range of clinical settings as diverse as hypertension/cardiovascular disease, migraine headaches and gastrointestinal ulcers (Watkins

1997). There is research to support the use of music to modulate heart rate and blood pressure, to enhance exercise programs and to relieve stress symptoms also in patients participating in cardiac rehabilitation (Metzger 2004).

Music has been shown to have beneficial effects also prior to and during invasive (diagnostic or therapeutic) medical procedures. Fifteen minutes of self-selected music prior to gastrointestinal procedures reduced patients' anxiety levels measured by The State Trait Anxiety Inventory (Hayes et al. 2003). Patients undergoing surgery with local anaesthesia experienced lower anxiety levels, heart rates and blood pressures when they listened to the music of their own choice during the surgery (Mok & Wong 2003).

Whether music therapy can be used as an effective nursing intervention to decrease anxiety and promote relaxation in ventilator-dependent patients is still controversial. A review article on this subject (Iriarte 2003) warned that although analysed studies showed a great reduction in state anxiety due to the intervention, the physiological measures (heart rate, blood pressure and respiratory rate) have been contradictory from study to study, reaching different conclusions. One more recent study (Almerud & Petersson 2003) showed a beneficial effect of music also by mechanically ventilated patients - a significant fall in systolic and diastolic blood pressure during the music therapy session with a corresponding rise after cessation of treatment.

Enhanced spatial-temporal reasoning due to enhanced cortical blood flow, i.e. enhanced brain activity owing to Mozart music (Sonata K.448) vs. other music (Bethoven's Für Elise and 1930s piano music) was observed both in healthy and Alzheimer's disease individuals in fMRI study examinig the effect of listening to music on cortical blood flow activation (Bodner et al. 2001; Johnson et al. 1998).

Emotional responses to music seem to be even more important for the beneficial effect of the music than the music itself. The use of music listening for depressed women due to its beneficial effects on heart rates, respiratory rates, blood pressure and tranquil mood states was supported as a body-mind healing modality (Lai 1999). Exposure to music, steady noise and fluctuating noise on blood pressure showed that the effects of music on blood pressure were modified not only by the melody and timbre but also by emotional responses during listening (Sakamoto et al. 2002).

Neural correlates of the often-powerful emotional responses to music are poorly understood. Emotional responses to pleasant and unpleasant music correlate with brain activity (cerebral blood flow changes) in paralimbic and neocortical brain regions (Blood et al. 1999). These regions have been previously shown to be associated with certain emotional processes. However, these regions differ from those that are active during processing of perceptual aspects of music, as well as from those attributed to processing different emotions. Concerning this, music may recruit neural mechanisms similar to those previously associated with pleasant / unpleasant emotional states, but different from those underlying other components of music perception, and other emotions, such as fear.

Intensively pleasurable responses to music correlate with activity in brain regions implicated in reward and emotion (Blood & Zatorre 2001). In response to subject-selected music that elicited the highly pleasurable experience of „shivers-down-the-spine“ or „chills“ the cerebral blood flow changes were measured. Subjective reports of chills were accompanied by changes in heart rate, electromyogram and respiration. Cerebral blood flow increases and decreases were observed in brain regions thought to be involved in reward/motivation, emotion and arousal, i.e. in the brain structures known to be active in response to other euphoria-inducing stimuli, connecting, thus, music with biologically relevant, survival-related stimuli.

Consistent with a model of hemispheric specialisation concerning perceived positive and negative emotions, proposed by Heilman (Heilman 1997), different emotions while listening to music (jazz, rock-pop, classical music and environmental sounds) are reflected in brain activation patterns (cortical lateralisation patterns). Positive emotional valence on perceived stimuli are accompanied by an increase in left temporal activation, negative emotional valence by a more bilateral pattern with preponderance of the right fronto-temporal cortex (Altenmüller et al. 2002).

Music can be effective in reducing stress-induced physiological reactions also in healthy persons. In healthy volunteers exposed to (classical) music or progressive relaxation after a stress manipulation, a reduction in physiological arousal as well as decreased heart rate were detected (Scheufele 2000). The stress-induced increases in subjective anxiety, heart rate and systolic blood pressure due to a cognitive stressor task (preparation for an oral presentation) could be even prevented by the exposure to the music (preparation for an oral presentation in the presence of Pachelbel’s Canon in D major vs. preparation in silence). Additionally, this music enhanced baseline salivary immunoglobulin A (IgA) levels (mucose protection).

Studies on the relaxation effect of music in healthy persons showed that classical music tend to cause comfort, whereby rock music and noise tend to cause discomfort (Umemura & Honda 1998). The exposure to relaxing classical music pieces such as Bach, Vivaldi and Mozart result in significant reduction of heart rate in healthy adolescents (Escher & Evéquoz 1999).

Heart rate variability i.e. activation of parasympathetic nervous system alters according to the kind of music. The repetitive (four sessions in a day) exposure to sedative music, excitative music and no music stimulation was performed in young healthy adults (students) on different days. Sedative music and no music situation induced both high relaxation and low tension subjectively. This was the case also for the excitative music, as the number of sessions increased. The changes in heart rate variability components (changes in low-frequency (LF) and high-frequency (HF) component of heart rate variability as well as changes in LF/HF ratio during sedative, excitative and no music states) suggested that excitative music decreases activation of parasympathetic nervous system (Iwanaga et al. 2005).

Concerning the effect of music amplitude on the relaxation response, an overwhelming preference for the soft music (60-70 dB) in comparison to medium (70-80 dB) or loud (80-90 dB) music was found in the study exploring both psychologically (preference scores and self-report) and physiologically (heart rate) effects of music amplitude on relaxation response, where participants were instructed to indicate their amplitude preference for relaxation. Males and non-music majors, however, preferred louder music more than females and music majors, who preferred softer music (Staum & Brotons 2000).

The positive effects of music on spatial-temporal reasoning in healthy persons seem to be associated with brain plasticity ability. The results of the studies concerning whether listening to a Mozart piano sonata temporarily (short-term) enhances spatial-temporal reasoning in college students (Rauscher et al. 1995) are not consistent with each other (McCutcheon 2000). Anyway, music training in young pre-school children enhances spatial-temporal reasoning – a significant improvement on the spatial-temporal reasoning test was found in the preschool children that received private piano/keyboard lessons (Rauscher et al. 1997). Music training produces long-term modifications in underlying neural circuitry in brain regions not primarily concerned with music. This could enhance the learning of standard curricula, such as mathematics and science, which draw heavily upon spatial-temporal reasoning.

Music could be also beneficially used to promote work performance. Information in the form of music is advantageous because it does not hinder work as does verbal information and it contains more information than warning noises. Studies on changes in work performance due to existence of sound i.e. in presence or absence of sound showed positive effect of music during mental workload i.e. decrease of the workload and the improvement of the work performance. Moreover, in the study using music based on their own heart rates as sound (Yokoyama et al. 2002), it was shown that music of one's own heart is relaxing and promotes concentration. Heart rate reflects various physiological states such as biological workload, stress at work and concentration on tasks, drowsiness and the active state of the autonomic nervous system. Music changes these physiological states for the better by relaxing people. In this study, electrocardiogram was converted to sound in real-time and presented via a sound source. Software analyses the heart trace from the monitors and measures the time between peaks, the „R-R interval" (for more information on this subject please see Chapter 4). This gives instantaneous heart rate, the frequency of consecutive heartbeats, rather than a rate averaged over a minute like standard pulse measurements. An algorithm written by Yokoyama converts the heart rate into pitch data that can be understood by a Musical Instrument Digital Interface (MIDI) – international standard for expressing music in the form of digital data. The proposed system sequentially inputs the instantaneous heart rate into the computer, converts the data into musical instrument digital interface, the digital music format, and outputs it from the sound source. Mental work performance was better in the presence of this sound, i.e. in the presence of rhythm of own heart. Those who listen to a melody derived from their own (instantaneous) heart rates stayed cooler and calmer under pressure. One who works in his/her own rhythm is more productive and healthy with less feeling of tension, time pressure and fatigue (this was tested on a five level scale). Subjective effects differed among subjects, but even when a subject felt subjective workload, the physiological workload measured from the heart rate variability turned out to be rather smaller than when no sound was present. On the other hand, subjects who did not feel subjective workload because of the sound improved their work performance. Furthermore, authors propose this system to be applied as biofeedback monitor for the further decrease of the workload and the improvement of the work performance according to worker's real-time physical condition and feelings. The computer and bio-signal interaction enables the beneficial effect of music on a worker to be enhanced by controlling music interactively in real time according to the physiological state of the worker. Actually, by adjusting the music volume interactively in real-time according to heart rate variability, the physiological state can be kept (shown in the coefficient of variance of R-R interval) and the improvement of biological conditions can be achieved. This monitoring system could be used in the future as the health care, stress management and the relaxation method.

Beneficial effects of music on stress-related behaviours were shown also in infants and toddlers (Marley 1984). It was shown that music accompanied with interaction with music therapist (relaxation, didactic games, movement, and songs) effectively reduces stress-related behaviours (defined as crying, throwing objects, absence of vocalisation, lethargy, and/or body tension) in hospitalised infants and toddlers ages 5 weeks to 36 months.

Human infants seem to possess a biological preparedness that makes consonance (pleasant melody) perceptually more attractive than dissonance (unpleasant melody). Young infants (4 months old) exposed to both consonant and dissonant versions of two different unfamiliar melodies look significantly longer at the music source and show less motor activity when hearing the consonant as compared to dissonant versions of each melody (Zentner 1996).

2.3. Music as acoustic stimulation for premature born infants

A known important role that stress plays for the course of majority of diseases, is even more important in conditions with fewer physical and emotional resources at one’s disposal, such as in pregnancy, labour and puerperium. Additional stress/fear situation in pregnancy diminishes placenta blood flow, which can lead to intrauterine growth retardation (IUGR) of the foetus. Increasing stress in pregnancy causes hypertension and proteinuria syndrome (PIH) as well as prematurely contractions, leading to premature birth. Release of stress hormone during labour reduces efficacy of uterine contractions, sometimes so strong that this can be the only reason for a Caesarean section (Simkin 1986). Noxious effects of stress on newborn baby at NICU can be indicated by lower blood oxygen-saturation level, greater need for an extra oxygenation, fluctuating blood pressure and heart rate, higher level of restlessness. In addition, a newborn baby in the NICU often experiences pain, which further increases the stress reaction and the cortisol level rise.

The stress hormone level elevation during pregnancy and labour can be reduced by music, as it was shown in several studies (Schwartz 2003).

Special acoustic properties that differentiate music from all other sounds could be beneficial also in premature infants. The existence of the lullaby is presumptive evidence that mothers have always, or nearly always, believed that it can quieten babies.

Evidence has accumulated that music might improve the physiological responses and growth of premature infants i.e. that music might have beneficial effects on premature infants' somatic and psychological development.

First studies on music stimulation in premature infants (Caine 1991) investigated the effect of tape recorded vocal music, including lullabies and children's music (30 minutes of the recording were played alternatively with 30 minutes of routine auditory stimulation three times daily). This kind of music stimulation significantly reduced initial weight loss, increased daily average weight gain, increased formula and caloric intake and significantly reduced length of the NICU and total hospital days. The daily group mean of stress behaviours for the group of premature and low weight birth neonates who received music stimulation was also significantly reduced.

Several further studies reported that music supported recovery from a stressful event such as heel-stick procedure or suctioning. Music was shown to be effective in reducing agitation and physiological instability, i.e. in reducing stress-related behaviours in premature infants with bronchopulmonary dysplasia following a suctioning as a stress-producing intervention (Burke et al. 1995). Heart rate, oxygen saturation levels, level of arousal, stressful facial expressions, and autonomic indicators were recorded.

Effects of music during recovery from heel-lance showed that music is an effective NICU intervention following a stress-provoking stimulus in infants older than 31 weeks post-conceptual age (Butt & Kisilevsky 2000). Heel lance elicited a stress response (i.e. increased heart rate, decreased oxygen saturation, increased state-of-arousal, and increased facial actions indicative of pain). Recovery period was shorter (the infants had a more rapid return of heart rate, behavioural state, and facial expressions of pain to baseline levels) in the presence of music. Comparing different interventions i.e. non-nutritive sucking, music therapy, combined non-nutritive sucking and music therapy, and no intervention in a random order each time after heel-stick procedure in neonates older than 28 gestational weeks (Franck & Miaskowski 1997) showed that the three comfort interventions significantly reduced neonates' heart rate, improved their transcutaneous oxygen levels and reduced their pain behaviour. Music therapy alone had the strongest effect on neonates' heart rate whereby music combined with non-nutritive sucking intervention had the strongest effect on neonates' transcutaneous oxygen levels and pain behaviour. A recent study (Bo & Callaghan 2000) confirmed that music combined with non-nutritive sucking reduces neonates' heart rate, improves transcutaneous oxygen levels and reduces pain behaviour of neonates in intensive care units having blood taken by a heel-stick procedure. These attainments made the music combined with non-nutritive sucking one of the most favourite pain management interventions in NICU.

The nipple feeding skill is not yet fully developed in premature infants. Nevertheless, the non-nutritive sucking has been shown to be effective both in facilitating development of nutritive sucking and in modulating behavioural state of premature infants providing more sleep and fewer restless states (Gill et al. 1992). The development of non-nutritive sucking as a pain management intervention as well as transfer of sucking behaviour from a non-nutritive to a nutritive event by premature infants is dependent on length of their hospitalisation (length of feeding by gavage tube) and on neurobehavioral development. Recently it was shown that music could function as reinforcement for non-nutritive sucking and support transfer from a non-nutritive to a nutritive event (Standley 2003; BMJ Publishing Group & Royal College of Pediatrics and Child Health 2003). Feeding rates measured pre- and post intervention combining music and non-nutritive sucking showed significantly increased feeding rates.

Infants' tolerance towards stimulation, especially female infants' tolerance increases in the presence of music. Music combined with multimodal stimulation, i.e. auditory, tactile, visual and vestubular stimulation (ATVV stimulation) paired with line singing of Brahms' Lullaby significantly benefited females' days to discharge, increased weight gain per day for both males and females and increased both male and female infants' tolerance for stimulation with females' tolerance increasing more rapidly than males (Standley 1998).

Comparison of therapeutic effects of music and mother's voice on premature infants in one study (Standley & Moore 1995) showed that infants who listened to lullaby music (10 infants) had significantly higher oxygen saturation levels and fewer occurrences of Oxymeter alarm during (20 minutes) auditory stimuli than did those listening to the mother's voice recording through earphones (10 infants). However, this effect was present only on the first day and disappeared on the second and third day of the three consecutive days the auditory stimulation was performed on, and even significantly depressed oxygen saturation levels were registered after auditory intervention on the second and third day.

Auditory stimulation of premature infants with music can have a calming effect on premature infant through a beneficial effect on local cerebral microcirculation and oxygenation (cerebral blood flow and cerebral oxygen saturation) as shown by one study previously performed at the Department of Neonatology, University Children's Clinic, University of Heidelberg (Linderkamp et al. 2004). Effects of different kind of music i.e. classical, pop and lullaby music were investigated. Music, especially lullaby music increased the amount of total- and oxy-haemoglobin in the frontal lobe as well as cerebral oxygen saturation in the frontal lobe indicating, thus, a decrease of metabolic rate of oxygen (and decrease of metabolic processes), while cerebral blood flow velocity did not change significantly during different music performances.

A recent meta-analysis (Standley 2002) provides further support to the view that music is good for premature infants. Ten studies met predetermined inclusion criteria. Six studies used recorded, free-field music, usually lullabies, three used recorded music through earphones, and one used live singing. This meta-analysis on music research with premature infants in the NICU suggested that music has statistically significant and clinically important benefits for premature infants in the NICU. Music at 55 to 80 dB was associated with improvements in behavioural state, heart rate, respiratory rate, oxygen saturation, weight gain, feeding rate, non-nutritive sucking, and duration of hospital stay. Effects were not mediated by infants' gestational age at the time of study, birth weight, or type of music delivery or by physiologic, behavioural or developmental measures of benefit. Clinical implications for research-based music therapy procedures were provided: The author of this meta-analysis recommends lightly rhythmic music with unaccompanied voice or voice plus one instrument, constant rhythm and volume (low seventies dB) and no more than 1.5 hours per day, alternating 30 minutes on with 30 minutes off. Live singing of lullabies is regarded as excellent. Musical/sound generating toys and mobiles are definitely disapproved. NICU health care professionals should be cautioned about other uses of music undocumented in the research literature as beneficial to premature infants receiving intensive care (such as live instrumental performances in the NICU environment, radio stations tuned to selections preferred by the medical staff rather than selected for the benefits of the infants, and classical music selections widely acclaimed to enhance intelligence). Concerning the fact that music, in contrast to ambient sound and noise, contains information, the author of this meta-analysis proposes even louder volume levels of music in NICU than has been previously recommended (Graven 2000).

Except for its potential for soothing, music can be used in the NICU for its potential to promote learning and neurological development (Standley 2002).

Aural perception requires the translation of vibrations and is learned or developed over time. A newborn human shows preference for his/her mother's voice and to musical pieces to which he/she was previously exposed, indicating a capacity to learn while *in utero* (Gerhardt & Abrams 2000). The study concerning prenatal foetal exposure to music (James et al. 2002) showed that the mean heart rate was higher in exposed foetuses and more state transitions were recorded due to the music exposure. (Computerised assessment of foetal heart rate and activity was documented and neonatal behavioural states were recorded.) These effects were carried over into the neonatal period when prenatally exposed newborns manifested also more state transitions and spent a higher proportion of time in awake states.

Music is an auditory stimulus with many cognitive elements such as melody, rhythm, harmony, timbre, form, style and expression characteristics that are processed simultaneously or in sequence. It is shown that experience affects music processing in infancy. The results of one study (Lynch et al. 1995) suggests parallel development of music and speech perception i.e. parallel developmental tendencies in the perception of music and speech that may reflect acquisition of perceptual abilities for processing of complex auditory patterns.

Since development of cognitive functions rely very much on language acquisition, and the prerequisite for the appropriate language acquisition is properly developed auditory system (both at peripheral/sensory level and at cognitive/high order level), whether early exposure to music can stimulate music processing, development of speech, language acquisition, and consecutive development of cognitive functions is the subject of current research interest.

Chapter three

Mother's voice as acoustic stimulation for premature born infants in neonatal intensive care unit

3.1. Parent-infant interaction and the concept of intuitive parenting

The very beginning of the communication between an infant and its parents happens long before an infant learns to speak. An intensive parent-infant communication can be seen from the very beginning of postnatal life and even prenatally.

The human neonate demonstrates the very particular behaviours, behaviours which are quite different with an object and with a human interactant, demonstrating, thus, an expectancy and competence for interaction with his/her caregiver (Brazelton et al. 1975). Microanalysis of video-tapes, observed in the early seventies, showed a set of infants' interactive behaviours: all parts of infant's body move in smooth circular patterns as the infant attends to the mother, his/her face-to-face attention to the mother is rhythmic with approach-withdrawal cycling of extremities. This attention phase is followed by turning away and a recovery phase in a rhythm of attention-non-attention, which seems to define a cyclic homeostasis curve of attention, averaging several cycles per minute. When the mother violates infant's expectancy for rhythmic interaction by presenting a still, unresponsive face to him/her, the infant becomes visibly concerned, his/her movements become jerky, he/she averts his/her face, then attempts to draw the mother into interaction. When repeated attempts fail, the infant finally withdraws into an attitude of helplessness, face averted, body curled up and motionless. If the mother returns to her usual interactive responses, the infant comes alive after an initial puzzled period, and returns to his/her rhythmic cyclical behaviour. This attentional cycling has been shown to be diagnostic for an optimal mother-infant interaction, since it is not present in more disturbed interactions.

Parent, as another interactant in the parent-infant interaction, also dispose of specific competence for handling with the neonate. Mother's/father's behaviour towards their newborn baby encloses a set of specific reactions, which flow rapidly, regularly, frequently and almost without any conscious control (Papoušek 1979).

Microanalytic studies of the parental interactive behaviours in early parent-infant interactions discovered *a wide spectrum of parental competence* to deal with their newborn child, i.e. the repertoire of parental behaviour has been shown to be extremely extensive. A set of intuitive components in parental behaviour which fulfil important assumptions of perception, learning and cognition in the newborn was discovered (Papoušek & Papoušek 1981a). Parental "babytalk", imitation and contingency, control of behavioural states, and the support of visual contact are the typical examples.

When facing a newborn, the parent uses so called *"babytalk"*, i.e. the parent's way of speech is slower, clearly articulated, plain segmented, in higher frequencies and with an impressive speech melody when compared with the speech facing an adult.

The mother directs her attention towards the behaviour of the newborn, which signalises to her *the behavioural state of the newborn*. For example, the mother directs her attention towards the position and movements of the hands or towards muscle tone and hunger reaction in the mouth region. The mother touches the mouth region of the child or his finger, as if she would like to assess the muscle tone. With the increasing level of waking and state of hunger rises also the resistance, and the touch triggers sucking movements, vivid opening the mouth, sucking reflexes, vigorous rooting. Similarly, the position of the newborn's hands, the finger muscle tone, readiness to grasp, open or closed fists and firmness of grip inform the caretaker about different levels of wakefulness. Firm clenched fists, sometimes with anaemic fingertips, is a sign of uneasiness, anxiety or even harassment due to either a frustrating situation or a situation of a cognitive overload during the processing of the environmental impressions. The assessment of the infant's behaviour state, i.e. level of wakefulness facilitate caregiver decisions whether to intensify stimulation or allow the newborn to recover in peace.

The eye contact plays unmistakably a many-sided role in the communication between the newborn and parents. The eye contact signalises the mother the degree of her child's attention. As soon as the mother catches the eye contact of the child, she answers almost automatically with one full-of-expression-greeting - *the typical "greeting response"* - a slight retroflexion of head, raised eyebrows and widely opened eyes, usually followed by a verbal greeting and/or smile. This contingent greeting acts as a rewarding encouragement for the baby to look at the mother's face over and over again. In order to make the eye contact easier, the mother spontaneously keeps a distance of about 20-25cm away from the neonate face when she talks to the baby or entertains it.

The first eye contacts between mother and her newborn are particularly intensive experiences for the mother and they facilitate *the development of bonding and attachment* between parent and infant. Especially an early parent-infant contact is very important for the optimal development of parent-infant attachment (Klaus & Kennell 1976; Klaus et al. 1972; Kennell et al. 1974).

Another example of parental contingent response is the adult's *imitative behaviour* (Papoušek & Papoušek 1981a). The very strong (hard to suppress) tendency of the mother to imitate the newborn from the very beginning offers an infant something like a so called "biological mirror" or "biological echo", something that newborn can simultaneously control and repeatedly manipulate through its behaviour, which helps him later to develop his own ability for imitation. This, on the other hand, is an important step in the development of speech and the socialisation process.

The major functional components of parent's behaviour in parent-infant face-to-face interaction are *affective quality of parent's behaviour and its contingent relationship* to baby's behaviour. Infant's response is specific to the type of affective expression the mother displays. Flat, withdrawn maternal affective expression is associated with infant's distress whereby intrusive maternal expression is associated with increased gaze aversion (Cohn & Tronick 1989). Concerning contingency, the same stimulation that had elicited little orienting and fast habituation might lead to striking attachment behaviours if made contingent upon the infant's act (Papoušek & Papoušek 1983). Lack of contingent responsiveness is usually common in multiproblem families (Cohn & Tronick 1989).

Further microanalysis observations of interaction between parent and infant discovered that the newborn infant has not only competence for interaction but also *competence for learning*. The newborn is able to learn from the first week of life and is born with an innate capacity to respond with adequate forms of learning to certain structures of environmental stimulations (Papoušek & Papoušek 1983). The learning process (the successful course of integrative processes) requires an optimal infant's behavioural state. Learning is most successful during waking connected with vivid and well-coordinated movements and/or quiet vocalisation, excluding fussing or crying. The maximum of effective learning situations appears to occur in social interactions with caretakers and in play situations. The stimuli and the learning situation must be simple and repeated many times. Parents always adjust to the infant's individual properties. For the infant it is particularly important how predictable the adult's behaviour is and how contingent it is on the infant's activity.

Also parents are competent and motivated both for interaction and teaching. A parent seems to be *a perfect didactic counterpart* to the newborn infant's competence for learning. Previously unknown forms of parental didactic behaviour interventions, that might have been escaped the observer's attention, because caregivers carry them without being knowingly aware of them, i.e. parental behaviours facilitating the conveyance of preverbal information to infants and corresponding to biological precursors of didactic interventions have been discovered owing to microanalytic studies of early parent-infant interactions. The parent shows a strong interest in any sign of cognitive progress in the infant, tends to select the type and amount of stimulation according to the infant's capacity to process it and is very sensitive to feedback cues in that capacity (Papoušek & Papoušek 1987). Parental behaviours show specific, obviously biological adaptation to the constraints of the newborn's integrative competence (Papoušek & Papoušek 1981a).

The mentioned parental behaviours in dyadic interaction with the newborn show qualities that assign these behaviours an intermediate position between categories of innate reflexes and responses requiring rational decisions; that is the position of *intuitive behaviours*. Parenting competence behaviours are elicited in miliseconds. They appear usually after a period of 200 to 600 miliseconds i.e. the latency of parenting competence behaviours is above the latency of innate simple reflexes and below that of conscious, rational decisions and intentional actions. Therefore, one speaks about intuitive parenting, i.e. intuitive parenting competence (Papoušek & Papoušek 1987). Microanalysis shows that in parent-infant interchanges, there is not enough time left for conscious rational decisions at each step of parental behaviour. Parenting competence behaviours are almost without any conscious control. Individuals are unaware of carrying out these behaviours. They sometimes deny or misinterpret their occurrence and, if they become aware of them, typically find them difficult to control. Without being aware of it, the parent, thus, facilitates integration of experience, development of self-perception, intentionality, nonverbal and verbal communication in the infant as well as mutual familiarisation (Papoušek & Papoušek 1981a).

The intuitive behaviours detected in parental interactions with infants have been found not only in mothers, but also in fathers, other caretakers and even children. They have been found somewhat *universally across age, sex, and culture* (Fernald et al. 1989). Some of the intuitive behaviours are present in the period of infancy and persist for the entire life span of the individual. If parents are not available, almost any experienced member in the social environment is likely to possess similar didactic capabilities with which to complement and enhance the infant's integrative needs. The universality of such behaviours indicates the deep phylogenetic roots of observed behavioural patterns.

3.2. Importance of parent-infant interaction for infant's development

Parent-infant interaction has a crucial effect on infant's development.

First of all, intuitive parenting competence in the preverbal parent-infant communication has *crucial co-regulating functions within the scope of infant's developmental tasks*. Thus, regulation of feeding and sleep-wake cycle, affective behavioural regulation, regulation of attention and integration of experiences, regulation of attachment security and exploration, regulation of dependency and autonomy are co-regulated through parent-infant communication.

Parent-infant communication provides an infant also with a crucial didactic support (Papoušek & Papoušek 1987; Papoušek 2000). An infant has an early ability to learn, to cognitively process informational input and integrate experiences from interactions with the environment into behavioural adaptations. Infant's integrative capacities have the role in the development of self-regulation or in interactions with the environment. Parental behaviours, corresponding to biological precursors of didactic interventions, facilitate the conveyance of preverbal information to infants and serve as a didactic counterpart to the infant's integrative competence. As mentioned, not only conveyance of preverbal information and integration of experiences, but also development of self-perception, intentionality, nonverbal and verbal communication are facilitated through parent-infant interaction. Moreover, early parent-infant interaction functions as a didactic system to support the development of thought and speech. Parents unknowingly adjust the structure and dynamics of speech to the constrains of infant's capacities, detach prosodic musicality from lexical structure and use it in particularly expressive forms for the delivery of the first prototypical messages. In this and other similar ways, parents offer an abundance of learning situations in which infants can try out various integrative operations. The early intuitive support of communicative development and its playful character are suggested as species-specific determinants of speech evolution (Papoušek & Papoušek 1986; Papoušek 1984).

Parent-infant interaction has great importance for infant's optimal *cognitive development* too. Motor activity and social interaction do play particularly important roles in the cognitive development of infants (Papoušek & Papoušek 1975).

Furthermore, parents' (or caretaker's) love, attention and affection, and above all stimulation, impulse and encouragement are essential for the infant's further development. Parent-infant face-to-face interaction is *central for infant's mental health* (Papoušek 2000) *and optimal socio-emotional development*. As already mentioned, parent-infant interaction facilitates mutual familiarisation and is important for the development of parent-infant attachment and development of infant's socialisation process.

A continuous uninterrupted mother's care and devotion to the child is necessary for the *normal physical, psychical and social development* of the child, indeed for its survival. The most elementary precondition for mother's care is the physical presence of the mother or one corresponding replacement (caretaker) (Spitz 1976; Spitz 1967). Interaction with the caretaker is both a need and a condition for the normal development of a child. In addition to the physic presence of the mother/parent/caregiver, adequate caretaking is essential for an infant's optimal development. When the child experiences inappropriate care from his/her mother, the child development can become less advanced, infirmity and damages to different extent can appear. Missing parent (caretaker) or inadequate parenting (caretaking) compromises normal infant development leading to a well known social deprivation syndrome (Hellbrügge et al. 1973, Hellbrügge 1966). Because, even with the degree of competence and autonomy admitted to the newborn, it is the adult caretaker who must show a maximum of adjustment during interaction in order to facilitate the newborn's cognitive start and arrange appropriate lessons. In spite of autonomy and competence attributed to the newborn, its initial capacities are insufficient, the first post-natal interchanges with the environment lead to a successful integration of experience only under very favourable conditions, which may be rare unless they are adjusted to the newborn's constraints (Papoušek & Papoušek 1983; Papoušek & Papoušek 1981a).

3.3. Intuitive parenting regulation as precondition for the adequate parenting

In general, parent-infant interaction has a beneficial effect on infant's development. The most beneficial effects of parent-infant interaction on an infant's development are the result of an optimal social interchange/exchange between the parent or caregiver and the infant in the parent-infant relationship.

However, it has become evident not only how early social interchanges between infants and caretakers can effectively contribute to the infant's optimal development and lessen various noxious interventions, but also how far interactional failures can lead to the opposite. It appears that a major determinant of children's development is related to the operation of the parent-infant communication system. Positive development may be associated with the experience of coordinated interactions characterised by frequent reparations of interactive errors and the transformation of negative affect into positive affect, whereas negative development appears to be associated with sustained periods of interactive failure and negative effect (Tronick 1989). Matching and interactive repair processes are particularly important for the parent-infant dyad.

Parent-infant relationship is, nowadays, interpreted as an interaction, an interrelation, or an interrelated relationship. Instead of the previously popular behaviouristic stimulus-reaction model, the parent-infant relationship, as well as the parent-child relationship, is currently understood and considered rather in the sense of the dynamic designed interactional model or that is to say interpreted as the systems theory transactional model. In this sense, both partners mutually influence each other and they steadily change themselves through this influence. Each response of one partner is at the same time the stimulus for another partner (Papoušek 1979).

Mother-infant communication normally functions as a primary protective resource providing the infant with crucial regulatory and didactic support, on the one hand, and the mother, on the other hand, with reassuring positive feedback (Papoušek 2000). This reassuring positive feedback in mother-infant relationship provides regulatory support for the mother. Thus, the mother-infant relationship serves for the mutual regulation (mutual affect regulation), as human relationships in general do (Stern 1979; Stern 1995).

The regulation of the mothers' intuitive parenting competence is to a great degree mediated by the mothers' psychological condition. Lack of self-confidence and depression promote maternal feelings of incompetence and helplessness, and may, thus, enhance a mother's postpartum depression (Papoušek 2000). The interaction between postpartum depressed mothers and their infants is characterised by a lack of responsiveness, by passivity or intrusiveness, withdrawal and avoidance, as well as a low level of positive expression of affect, thus an impaired capability to regulate the infant's affect (Reck et al. 2004). Maternal depression predicts less optimal mother-infant interactions and insecure attachment, problem behaviours and lower social-emotional competencies in toddlers (Carter et al. 1998). Depression, exacerbation of neurotic conflict, borderline personality or other psychiatric disorders may seriously interfere with the mother's intuitive competence. Maternal psychopathology significantly contributes to low-key expression and maladaptive patterns of intuitive parenting (Papoušek & von Hofacker 1998). For these reasons, even mild forms of maternal psychopathology must be considered as one of the factors that increase the risk of long-term negative outcome on infant's mental development and the developing parent-infant relationship.

Parent-infant exchanges may be disturbed in various other ways. The parent may be living in adverse conditions; the parent may have ambivalent attitudes towards the infant after an undesired pregnancy; marital conflicts may be redirected towards the infant; the parents may lack adequate models of child rearing from their own childhood; or some of them may suffer from various other illnesses or disorders (Papoušek & Papoušek 1983).

Next to the mother's psychological condition, *the infant also has a role in regulating intuitive parenting*. The infant's behaviour and regulatory problems are crucial for understanding the regulatory dynamics of intuitive parenting. The regulation of intuitive parenting depends to some degree on the infant's appearance, but even more on the immediate messages of the infant's feedback cues. Positive cues (visual regard, smiling, cooing, cuddling, calming) evoke feelings of self-efficacy and encourage the parent to rely on his/her intuitive competence. Negative feedback cues (inconsolable crying, for example), on the other hand, may consequently stop the (soothing) parent from relying on his/her intuitive competence.

The present interpretation of early behavioural development with more adequate interactionistic models offers a new explanation of interactional failures responsible for the linkage of dangerous vicious circles. Even a deviation of little clinical significance can cause major problems because it may function as a starting point for a chain of reciprocal consequences which represent a vicious circle. This pathogenetic mechanism has attracted only little attention in clinical disciplines and has been approached mainly from behaviouristic or psychoanalytic positions (Papoušek & Papoušek 1983).

The mentioned inconsolable crying provides the most powerful negative feedback cues (squirming and back-arching, lack of calming, resistance to cuddling) for the parent. Therefore, in interactions with a persistently crying infant (Papoušek 2000), for example, the concept of maternal sensitivity (Ainsworth et al. 1974) or responsiveness is turned upside-down: perception of infant signals, correct interpretation, prompt and adequate response become problematic. Thus, mother and infant become trapped in dysfunctional interactions. Parental intuitive support becomes dysfunctional, and fails, particularly if parents themselves become tense and irritable. The persistence of such condition is a long-term risk for infant mental health.

Such milder forms of interactional failures, leading to neurotic (regulation) disorders in infancy and/or to neurotic disorder in parents, are relatively frequent. Next to this, also the clinical syndrome of 'maternal deprivation', new syndromes of 'maternal rejection' causing dwarfism, or 'child-abuse' causing even death have been introduced in paediatrics and developmental psychiatry. They exemplify serious outcomes of vicious circles initially resulting from minor deviance, perhaps mere prematurity of the infant or an unwanted pregnancy in parental history (Papoušek & Papoušek 1983).

3.4. Advantages of an early parent-infant interaction

Physical presence of the mother but also regulatory support for the mother's intuitive competence is needed for an optimal mother-infant interaction, i.e. optimal infant development.

Required regulatory support for the mother can be achieved and maintained through reassuring infant's positive feedback cues during mother-infant interaction.

An early experience of positive infant's feedback cues seem to be very important for the intuitive parenting regulation but also for the parental attachment behaviours. Mother's feelings of self-efficacy evoked by positive infant's feedback cues will encourage her to rely on her intuitive competence more and more, since the mother herself is not an inexhaustible source of rich stimulation (Klaus & Kennell 1976; Klaus et al. 1972; Kennell et al. 1974).

Therefore, by all the interventions that include a *separation of mother and child* one has to think about the possible interferences and impairments from both the child's and the mother's side.

Standard maternity ward practices, such as isolation of the newborn, separation of mother and infant immediately after birth, and the division of the family unit at the very time when it is symbolically and in reality becoming a family unit have been called into question

(Newman et al. 1976) when several studies filming mother-child first contact showed *differences in maternal attachment behaviour* (Klaus et al. 1975; Kennell et al. 1975). Shortly after birth there is a sensitive period which appears to have long-lasting effects on maternal attachment and which may ultimately affect the development of the child.

Behavioural and physiological observations of infants and mothers have shown them *ready to begin interacting in the first minutes of life* (Klaus 1998). The most visually striking observation of the first minutes of life is the ability of a newborn, if left quietly on the mother's abdomen after birth, to crawl up to her breast, find the nipple, and begin to suckle (Widström et al. 1987). The odour of the nipple appears to guide the journey. A perfect complement to this newborn infant's ability is the mother's capacity to keep him/her warm on this journey. Infants held skin-to-skin on their mother's chests for the first 90 minutes after birth hardly cried at all compared with infants who were placed in carrycots after being dried and wrapped in blankets (Christensson et al. 1995).

Less abandonment i.e. more care for the child due to *the hormonal release, stimulated by the touch of the mother's nipple by her infant's lips*, were also noted. If an infant's lips touched her mother's nipple in the first hour of life, these mothers kept their infants 100 minutes longer every day than mothers who did not experience suckling until later (Widström et al. 1990). The touch of the mother's nipples by her infant's lips releases oxytocin and plenty of (19 different) gastrointestinal hormones in both the mother and the infant, this being especially pronounced following birth in women who held their infants skin-to-skin. Oxytocin level is elevated after placenta expulsion and with each breastfeeding, providing thus a biological mechanism that may enhance the bonding of the mother to her infant.

That *the suckling in the first hours of life may contribute to reduced abandonment* was unexpectedly observed in several countries, after UNICEF initiated, in 1990, a 10-point program called "The Baby-Friendly Initiative". When a mother is permitted to have early contact, an opportunity for suckling in the first hour, and rooming-in with her infant, she will breastfeed more successfully and for longer periods of time. These interventions were incorporated into this UNICEF program. In places where a disturbing number of infants had been abandoned by their mothers in the maternity hospital, this large-scale change in care, i.e. the introduction of early contact with suckling and continuous rooming-in has significantly reduced the frequency of this sad outcome (Klaus 1998).

A meta-analysis of the results of two studies concerning the question "is the reduced abandonment the result of (early or increased) mother-infant contact or increased sucking or both" (O'Connor et al. 1980; Siegel et al. 1980) presented a statistically significant finding that additional mother-infant contact in the first days of life reduces later abuse and neglect (Klaus 1998).

Anyway, *the care a mother receives in labour may determine, in part, the way she cares for her infant*. Continuous support during labour by an experienced woman (known as a doula) significantly reduced the length of labour, the need for pain medications, operative vaginal delivery, and in many cases the number of caesarean sections. Moreover, the supported mothers were significantly less anxious, less depressed and had higher levels of self-esteem than those in the control group. Furthermore, the supported mothers often rated their infants as "better" than standard infants, more beautiful, clever, and strong. In contrast, the control group mothers rated their infants as being almost as beautiful, clever, and strong as standard infants (Klaus 1998). And infant's appearance is, as mentioned, important to some degree for the regulation of intuitive parenting, and thus for the optimal parent-infant relationship.

3.5. Parent-infant interaction with premature born infant

Premature birth affects parent-infant relationship in several respects.

First, due to the immaturity, premature infant's behavioural cues are less pronounced and more difficult "to read" (Als 1999; Fisher & Als 2003). Many mothers of premature born infants appeared to be utilising their infants' behaviour as a guide for their own behaviours and reported that their infants' behaviours had specific meaning. However, an equal number of mothers were not ascribing meaning to their infants' behaviours and did not appear to be using behavioural cues (Oehler et al. 1993). Responsiveness to the signals of infant's interactional readiness as well as to the first signs of distress could easily be misinterpreted.

Second, by the premature birth, the mother is unexpectedly and therefore unpreparedly separated from the infant. This lack of preparedness disturbs the transition to parenting, as one of the most dynamic family life cycles (Frevert et al. 1996; von Klitzing 1994; Ftenakis et al. 2002; Gloger-Tippelt 1985). The normal transition to parenting during pregnancy and infancy has several phases. The first 4-12 weeks of pregnancy (1.-3. month) are characterised by feelings of insecurity/uncertainty. This phase is followed by the adaptation phase which lasts from 12.-20. gestational weeks (4.-5. months). In the next phase, between 20. and 32. gestational weeks (6.-7. months) the parenting will be put in concrete terms, i.e. it becomes clear and certain, real and existing in the form that can be seen and felt. This phase is also characterised by progressive increase in antenatal attachment (Righetti et al. 2005). The weeks afterwards (32-39. gestational weeks i.e. 8.-9. months) are characterised by anticipation of birth, preparation for it and "nest-building". The birth phase usually happens between 39.-41. gestational weeks (Gloger-Tippelt 1988). The transition to parenting in the case of premature birth is interrupted. Exactly when the parents start to put parenting in concrete terms and are not attuned to the birth at all, very premature infants (28.-31. gestational weeks) and extremely premature infants (23.-27. gestational weeks) are already born. Instead of preparing for the birth in the anticipation phase, the mother and the father are already parents of an infant at a neonatal intensive care unit (Linderkamp 2005a; Vonderlin 1999). The parenthood has started like in a bad dream.

Due to the unexpected pre-term labour, the mothers of premature born babies are themselves "premature mothers" (Zimmer 2003; Linderkamp 2005a, Bruschweiler-Stern 1998). The pregnancy is not completed and the mother feels her pregnancy as unfinished. She is not pregnant any more, but does not feel like a mother either. She carries the child neither in her belly nor in her hands. At approximately 7 months of pregnancy, the mother has a fairly well-defined image of her infant, usually that of a vigorous, active, and gratifying 3-month-old not a fill-term neonate. Unfortunately, with an early birth, she finds herself facing neither a gratifying 3-month-old nor even a solid and well developed full-term infant. Instead, she encounters an infant who is frail, not very pretty, fragile, hyperdependent, and easily overwhelmed; she is a premature and disappointed mother. Even more, this unfinished and vulnerable infant makes her feel like a mother who has not been able to fulfil her pregnancy and become a real mother. She has a sense of being inferior, not being good enough, being less competent since she was not able to carry the baby to full term. She blames herself, searches for reasons she could have caused the premature labour, feels guilty. Instead of the expected social valorisation through the mother role, she feels it rather as devaluation of her person. She fears for the reaction of the family, friends, acquaintances and colleagues, which are, in fact, often hurtful. She is a mother who is premature, disappointed and isolated. She experiences herself as vulnerable and having failed.

The parents of premature born infants can not realise their protective and supportive role. The accommodation, the nourishment and the treatment of their child, as well as decision making are only partly under their influence and responsibility. They have to accept the medical and nursing personnel that take over these roles, as well as the neonatal intensive care unit. Death or possible remaining handicaps provoke their worst fears. This loss of autonomy and the determination of the situation being beyond parents' control reinforce the feeling of incompetence and failure. The feeling of incompetence is confirmed by the fact that specialists and sophisticated equipment are needed to care for her infant, and worse – that she can do nothing for him/her. The mother blames herself, reproaches the partner and/or the medical personnel, mistrusts or even accuses the medical personnel (Linderkamp 2005a, Bruschweiler-Stern 1998).

Further, except for the bodily separation, the mother and the child are also spatially separated by an inevitable transfer of the premature infant to a neonatal intensive care unit. The feeling of uselessness is reinforced by this physical separation from her infant who is placed in a neonatal intensive care unit. Such separation due to the premature birth can affect parent-infant attachment development. Filming of the first mother-newborn contact after delivery (Klaus et al. 1975; Kennell et al. 1975) showed that mothers begin touching their infants' extremities with their fingertips and proceed within a few minutes to a palm contact on the trunk having an intense interest in eye-to-eye contact whereby mothers of premature infants show only fragments of this behaviour. But even mothers of premature newborns show significantly more attachment behaviour when they are offered an early contact with their premature infants when compared to mothers whose first contact with their infants was three weeks after delivery. However, the premature infants born at the gestational age of 32 weeks or more, with birth weight of 1500g or more, show normal attachment behaviour at the age of 12 and 18 months and are at no higher risk for insecure attachment than their full-term counterparts, although their mothers are often assessed as less sensible and their mother-child interaction as less synchronous (Gutbrot & Wolke 2003). This is, unfortunately, not the case with the (very and extreme) premature infants born at less than 32 gestational weeks, with birth weight less than 1500g and higher medical risk, which are more at risk to develop insecure attachment.

Parental intuitive support in parent-infant interaction with premature baby can be compromised, therefore, solely due to prematurity. Even without existence of any maternal psychopathology, mothers of premature born infants easily suffer from lack of self-confidence, feelings of incompetence and helplessness, which, in addition to the immaturity of infant's cues, affect parent-infant interaction. Since infant's positive feedback cues are very important for the regulation of the intuitive parenting competence and necessary for the feeling of parental self-efficacy, the mothers of premature born infants (similarly as the mothers of persistent crying infants, for example) could experience less positive feedback cues due to the immaturity of their newborn baby and feel less self-efficacy consequently.

It is much easier for “the premature parent-infant couple” to slip into a less optimal interactive pattern, the pitfall of dysfunctional interactions and consequent interactional circulus vitiosus (vicious circle). The analysis on effects of preterm birth and the perinatal infant health condition on mother-infant interactions during undressing of the infant and face-to-face interaction has shown that mother-infant pairs with preterm infants (23-31 gestational weeks and 32-36 gestational weeks) did not differ in interactional variables from those of healthy term infants (control group) (Schermann-Eizirik et al. 1997). Nevertheless, comparison of mother-infant interactions of pre-term and full-term infants showed that term infants more often led the interaction, confirming thus, the less optimal interaction pattern found in mother-infant interactions with pre-term infants (Lester et al. 1985). In addition, the birth of a full-term infant in need of neonatal intensive care affected maternal and infant interactive behaviour i.e. less optimal interactive pattern was observed for their mothers (Schermann-Eizirik et al. 1997).

Actually, mothers of premature born infants show frequently one of two interaction patterns: they are either passive, withdrawn, less involved in the interaction, and therefore respond apparently less to the infant’s signals, or they are excessively stimulating, intrusive and over anxious. Both interaction patterns are considered as indication for low sensibility and sensitivity (Gutbrot & Wolke 2003).

However, parent-infant relationship is affected not only by parental sensitivity, structuring, non-intrusiveness and non-hostility, but also by parental adversity, stress and anxiety (Biringen & Robinson 1991; Biringen et al. 2000). It is possible that the underweight newborn’s fragile organisation elicits anxiety in the caretaker which makes interaction difficult (Als et al. 1976). The Brazelton examination (BNBAS) differentiated full-weight and underweight newborn infants on the reflexes of walking, crawling and passive movements of arms and legs, and on rooting and sucking. More important, Brazelton examination differentiated these two groups on behaviours that are important for the caretaker of the baby: attractiveness, need for stimulation, interactive processes and motor processes. The underweight infants showed temperamental organisational difficulties and some indication of psychosomatic reaction to stress in the follow-up during the first year.

Additionally, parental stress and anxiety can have a negative influence on infant’s somatic development and even lead to higher somatisation of premature born infants. Comparison of high somatisation of extremely low birth weight premature infants (ELBW) with “normal” somatisation of ELBW premature infants confirmed the importance of parental factors in relation to somatisation (Grunau et al. 1994). Non-optimal parenting may contribute to the development of inappropriate strategies for coping with common pains of childhood, or of chronic pain patterns, in some children who have experienced prolonged or repeated pain as neonates.

Furthermore, the existence of a prematurity stereotype as well as adult expectations influence perception and behaviour: mother-infant interactions of mothers with unfamiliar full-term infants who were labelled either full-term or premature showed that infants who were described as premature were touched less and given more immature toys to play with, were rated as smaller, finer-featured and less cute, and were liked less than infants who were labelled as full-term. In turn, infants labelled premature were during these interactions less active than infants labelled full-term (Stern & Hildebrandt 1986).

For all these reasons, pre-term infants are more frequently involved in interactional failures in general. Due to the psychophysiological impact of premature birth on the mother and the family during a vulnerable period of postpartum adaptation, *the prematurity may interfere with the mother's intuitive competence*, endanger the system's primary resource, and *push the system into vicious circles of dysfunctional interactions* characterised by negative reciprocity and potentially by mutual build-up of distress (Papoušek 2000).

Difficult temperament of a child or regulation deficits combined with parental fear, stress and burden due to premature birth can influence negative parental sensibility and sensitivity, which can lead to insecure or even disorganised attachment patterns, especially by extremely premature (very low birth weight) infants. According to birth weight of premature born infants, i.e. <1000g, 1000-1500g, >1500g, their caregivers experienced them as a burden in 22%, 18% and 15% of the cases, respectively (Vonderlin & Linderkamp 1996). However, a dysfunctional interaction pattern and insecure attachment pattern at later age seem to be the result rather of the infant's earlier behaviour problems (excitability, irritability, excessive crying) than of the lack of parental care and devotion (Gutbrot & Wolke 2003). This emphasises the fact that extremely premature born infants present a greater challenge for their caregivers.

Moreover, pre-term infants appeared to be slower learners than age-matched controls (Papoušek & Papoušek 1983). Earlier observations suggested that the pre-term infants may be less adjustable and predictable or more difficult to rear (Field 1977; Beckwith & Cohen 1978). Pre-term infants are over-represented in the samples of abused children (Elmer & Gregg 1967; Klein & Stern 1971; Fontana 1973) and in divorced populations (Leiderman &

Seashore 1975). Mothers often experience the care for pre-term infants as less rewarding and associated with difficulties (Goldberg 1977).

Furthermore, since the vulnerability of the central nervous system in addition to the infant's temperamental difficulty, on the one hand, and families with compromised parental functioning, on the other hand, all are predisposing factors for the clinical syndrome of persistent crying, premature born infants could be at higher risk for the development of this and/or other regulation disorders in infancy. Once dysfunctional patterns of preverbal communication become pervasive across most everyday contexts and domains of behavioural regulation, the parent-child dyad is at risk for lasting relationship disorders and the infant is at risk for behavioural disorders, such as sleep disorders, feeding disorders, temper tantrums, separation anxiety, or hyperactivity (Papoušek 2000).

Infant's mental health and the developing parent-infant relationships are at risk and more affected the more the parent's resources are strained by other factors. Therefore, in order to promote premature infant mental health and the developing parent-infant relationship, the family of the premature born infant should not only receive very careful care and support, but also be identified as a family in need of specialised intervention and offered some form of interaction-centred infant-parent care, counselling and psychotherapy. Supported parents can support and promote infants in practicing self-soothing capacities and developing self-regulation mechanisms. Care according to NIDCAP® (please see further as well as Chapter 1) has shown to be supportive also for the development of infant's self-regulation capacities.

3.6. Family-centred interventions in neonatal intensive care unit

The knowledge about the importance of the parent-infant interaction for the infant's development and the rising evidence of beneficial effect of parents' engagement in neonatal intensive care units eventually allowed the neonatal departments' guidelines and policies to steadily overcome the great fear from infection and involve parents in care for their own premature infants from the very beginning of their extra-uterine life.

Some studies results on different neonatal departments' interventions involving an early parent-infant contact with their premature infant showing beneficial effects on infant development, developing parent-infant relationship and parent-infant bonding and attachment are here presented.

It was shown that skin-to-skin (kangaroo) care vs. traditional care in premature infants has beneficial effects on infant development, both directly by contributing to neurophysiological organisation of an infant and indirectly by improving parental mood, perceptions, and interactive behaviour (Feldman et al. 2002). After kangaroo care, interactions between infants and their mothers were more positive at 37 weeks' corrected gestational age, mothers showed more positive affect, touch, and adaptation to infant cues, and infants showed more alertness and less gaze aversion. Mothers reported less depression and perceived infants as less abnormal. At the age of 3 months, mothers and fathers of kangaroo care infants were more sensitive and provided a better home environment. At the age of 6 months, kangaroo care mothers were more sensitive and infants scored higher on the Bayley Mental development Index and the Psychomotor Developmental Index.

An early (within 24 hours after birth) active maternal interaction with premature infant designed as combined tactile, auditory, visual and vestibular (ATVV) stimulation of premature infant by the mother (massage, talking, eye contact and rocking) may enhance mother-infant interaction. Mother-infant interaction was assessed prior to hospital discharge and significant differences for the maternal and infant behaviours were identified (White-Traut & Nelson 1988). Single or combined use of these stimulations resulted in significantly different pulse rate, respiratory rate and behavioural state of infants. Infants receiving any intervention with a tactile component showed increasing arousal (change in behavioural states), and increased pulse and respiratory rate during stimulation. Only the tactile stimulation group had a higher proportion of pulse > 180/minute, while combined ATVV group had higher proportions of pulse < 140/minute, suggesting, thus, that tactile stimulation alone may be too arousing for these infants while the addition of vestibular stimulation may modulate arousal and facilitate optimal arousal (White-Traut et al. 1997).

The development of the mother-infant relationship can be facilitated through use of music. The music assists in creating mutual regulated relationships. Moments of resonance and synchronisation serve to develop of bonding and contribute to the development of secure bonding (Lenz & von Moreau 2003). Through creating a space for relaxed, playful and not-designed being with each other, music enables both the mother and the child to interact (interweave) with each other, to share with each other, to experience resonance with each other and to have lively exchange and synchronisation in the relationship. Thus, parent-infant interaction combined with music of their own choice showed beneficial effect on the quantity and quality of parent-neonate interactions, the weight gain and length of hospitalisation of premature and low birth weight infants in neonatal intensive care unit (NICU), presumably through parental competence reinforcement. Parents in the experimental group received approximately one hour of instruction in appropriate uses of music, multimodal stimulation including massage techniques, and signs of infant overstimulation and techniques for its avoidance (Whipple 2000). Infant stress behaviours were significantly fewer and appropriateness of parent actions and responses were significantly greater for experimental infants and parents. In addition, length of hospitalisation was shorter and average daily weight gain was greater for infants whose parents received training, although these differences were not significant.

An early intervention in the form of family-centred and development-promoting care according to the Newborn Individualized Developmental Care and Assessment Program® (NIDCAP®) is the most advanced family-centred intervention for premature born infants in neonatal intensive care unit nowadays. The premature born infants care according to NIDCAP® has beneficial effects both on the development and the behaviour of the child as well as on the mother-child interaction at 3 years of age. The impact of supportive care according to NIDCAP® was assessed through developmental (Griffiths' Developmental Scale II), behavioural (Behaviour Symptom Interview) and tools for assessing mother-infant interaction (Parent-Child Early Relational Assessment Scale). Care of VLBW infants according to NIDCAP® have certain positive long-term effects on child's hearing-speech development, behaviour and mother-child interaction (Kleberg et al. 2000).

3.7. Mother's voice as acoustic stimulation for premature born infants

Acoustically, music and speech are fundamentally similar. Both use sound, and therefore are received and analysed by the same organs. Many of their acoustical features are similar, although used in different ways. In both music and speech, the perception of different subsets of acoustic features is categorical.

Comparison of processing of semantic meaning in language and music showed that both music and language can prime the meaning of the word, and both can determine physiological indices of semantic processing (Koelsch et al. 2004).

Musical elements of speech, consisting of pitch and melody, loudness and stress, tempo, rhythm, and tone perform important functions in verbal and preverbal parent-infant communication. In parental babytalk to the newborn, musical elements especially stand out.

Parents' intuitive vocalisations resemble singing more than speech and emphasise prosodic patterns through simplifications and intensified contrasting. These components facilitate the infant's perception and integration (Papoušek & Papoušek 1981b).

The analysis of musical elements in infants' preverbal vocal development shows that the vocal development ranges from vowel-like fundamental infant vocalisations and their musical modulation in relation to the infant's behavioural state and integrative processes, through playful experimentation with the production of sound to creative play with musical patterns and spontaneous singing (Papoušek 1981).

Closely interrelated with this development is the tendency for parents to engage the infant in dialogue and intuitively promote communicative and integrative capacities important for the acquisition of language, i.e. turn-taking in "dialogue", auditory imitation, the intentional use of sounds, global speech comprehension, prosodic patterning, and playful-creative exercise with sound patterns, all of which are performed primarily with the aid of musical elements (Papoušek & Sandner 1981; Papoušek 1981).

This parental tendency to rouse and maintain infant's attention (through high pitch, clear voice, upward melodic contours, moving rhythm, crescendo) alternates with the opposite tendency to calm the baby down in the case of excitement and lull it to sleep (through deep voice, downward melodies, slower, regular rhythm and decrescendo), both of these being of biological importance (Papoušek & Papoušek 1981b).

The human baby is already as a neonate especially sensitive to the frequencies of the human language, is able to differentiate human language and prefers tones to noises; it can recognise the mother due to her voice and can understand emotional expression forms of the language (Papoušek & Papoušek 1981b).

The foetal Cochlea is anatomically developed at gestational age of 18 weeks, foetus can hear from the age of 24 gestational weeks and from the age of 33 gestational weeks on a foetus can remember and recognise the mother's voice, her speaking melody and spoken words. The interpretation of acoustic and linguistic information on intrauterine recordings suggests that the prosodic features of speech (pitch contours, rhythm, and stress) are available to the foetus. This is compatible with the newborn responses and may contribute to the language acquisition during the first year of life. It is assumed that the learning of first language actually begins around this age (Moon & Fifer 2000).

Concerning already mentioned beneficial effects of parental involvement in parent-infant relationship on infant's development, auditory stimulation of premature infant in NICU through parent's voice in parent-infant interaction could serve not only to overcome the existing noise due to the technical sounds and to compensate the lack of natural intrauterine acoustic stimuli, as does the music, but moreover, to support and promote the infant's development including the development of infant's stress coping strategies i.e. infant‘s self-regulation competencies.

Furthermore, the development of speech as well as the infant's cognitive development and socialisation process can be also promoted. As shown in one study, the proximal and vocal responsiveness of the mother to infant distress in early mother-infant interaction resulted in better reading and conversation skills of the child in the school age (Coates & Lewis 1984), whereby distal responsiveness of the mother to infant distress was related to better mathematic achievement of the child in the school age, confirming again that an early mother-infant interaction has the predictive validity for the development of the child in early childhood.

Auditory stimulation of premature infants with their mothers' voices promotes development of the speech until the school age. The results of one study previously performed in cooperation with the Department of Neonatology, University Children's Clinic, University of Heidelberg, showed that the auditory stimulation of premature infants with their mothers' voices improved their language and overall development assessed at the pre-school age (Nöcker-Ribaupierre 1995; Nöcker-Ribaupierre 2003).

For these multiple reasons, parents should be very much encouraged to speak with their infants, to read to them and especially to sing to them from the very beginning.

PART TWO: **METHODICAL PRINCIPLES**

Chapter four

Heart rate and heart rate variability

4.1. Heart rate and heart rate variability – definition and clinical meaning

Electrical impulses coming from the heart can be recorded by an electrocardiogram (ECG, EKG). Aside from information about the heart rhythm and heart rate, an electrocardiogram also provides information about the distance between two consecutive heart beats as well as about the instantaneous heart rate.

This distance between two consecutive heart beats is usually measured as the distance between two consecutive ventricular depolarisation events, i.e. two adjacent QRS complexes, that is between two adjacent R-peaks, and is, therefore, called an R-R interval. Instantaneous heart rate is the heart rate calculated on the base of only one current R-R interval.

The electrocardiogram of healthy individuals exhibits periodic variation in R-R intervals. The R-R intervals do show variations from beat to beat, and the heart rate variability (HRV) refers exactly to these beat-to-beat alterations in the heart rate, i.e. refers to these variations in R-R intervals. Thus, HRV can be defined both as the oscillation in the interval between consecutive heart beats as well as the oscillations between consecutive instantaneous heart rates (Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology 1996). "Heart rate variability" has become the conventionally accepted term to describe variations of both instantaneous heart rate and R-R intervals.

Heart rate and rhythm are largely under the control of the autonomic nervous system. The parasympathetic influence on heart rate is mediated via release of acetylcholine by the vagus nerve. Muscarinic acetylcholine receptors respond to this release. The sympathetic influence on heart rate is mediated by release of epinephrine and norepinephrine and activation of β-adrenergic receptors.

The vagal and sympathetic activities constantly interact. Therefore, the R-R interval variations represent a fine tuning of the beat-to-beat control mechanisms. Vagal afferent stimulation leads to reflex excitation of vagal efferent activity and inhibition of sympathetic efferent activity. Efferent sympathetic and vagal activities can be modulated by central (vasomotor and respiratory centres) and peripheral (oscillation in arterial pressure and respiratory movements) oscillators.

Under resting conditions, vagal tone prevails and variations in heart period are almost completely dependent on vagal modulation.

HRV is based on an optimal interaction between sympathetic and parasympathetic nervous system. The existence of balance / homeostasis between these two regulatory systems is considered healthy. Health can be expressed as optimal ability of organism to adapt to inner and outer environment. The heart of a healthy person registers both inner and outer signals and reacts to these "measurement results" with subtle tuned changes / variations of the heart beat. These states of optimal interaction with inner and outer environment are experienced as "flow". On the contrary, when these states of optimal adaptation can not be achieved, one experiences "stress", i.e. disproportion between requirements and one's coping possibilities, or even symptoms of a disease. Once the heart cannot flexibly adapt to outer and inner stimuli, we speak about disease. Symptoms can be entirely interpreted as an expression of failed interactions. In this context, the HRV describes capability of heart to change the interval, from one heart beat to the next one, dependent on ongoing encumbrances and to adapt itself to permanently varying challenges very flexibly and very quickly.

In this sense, HRV can be regarded as measure for adaptation ability i.e. capability to react appropriately on permanently changing inner and outer encumbrances. HRV can be seen as a measure for the global adaptation capability ("Globalfitness") of the organism. According to Mück-Weymann (2005), HRV is a global indicator for the ability of oscillation / resonance and for the adaptability of bio-psychosocial functional circles within the exchange between the organism and environment. According to this concept, HRV is a "puffer"/an "interface" that relieves the interactions of the organism with the inner and outer environment, and therefore an indicator for the mind-heart-interactions.

The very first recognition that variable heart beat is a sign of good health came from the Chinese physician Wang Shuhe in the third century AD ("When the heart beats as regular as the woodpecker knocks or as the rain drips on the roof, the patient will pass away within four days".

In the modern science, HRV was rediscovered for the first time in the middle of 60's in the form of cardiotocography in the obstetrics, speaking not yet in current HRV terms, rather in terms of oscillation, deceleration and acceleration, but measuring/assessing, after all, an important prognosis out of the foetal heart rate variability.

The clinical relevance of HRV was first appreciated in 1965 when Hon and Lee noted that foetal distress was preceded by alterations in interbeat intervals before any appreciable change occurred in heart rate itself (Hon & Lee 1965).

Recognition of the significant relationship between cardivascular mortality, including sudden cardiac death, on the one hand, and increased sympathetic or reduced vagal activity of the autonomic nervous system, on the other hand, has promoted efforts for the development of quantitative markers of autonomic activity, whereby HRV acts for one of the most promising quantitative markers of autonomic nervous activity.

Introduction of power spectral analysis of heart rate fluctuations enabled quantitative evaluation of beat-to-beat cardovascular control. These frequency domain analyses contributed to the understanding of autonomic background of R-R interval fluctuations in the heart rate record. An understanding of the modulatory effects of neural mechanism on the sinus node has been enhanced by spectral analysis of HRV. (The efferent) vagal activity is a major contributor to the HF (high frequency) component, whereby literature data in respect to the LF (low frequency) component are in disagreement. The HF vagal component of the power spectrum is augmented during non-REM sleep, in normal subjects, whereas this increase in HF is absent in post-myocardial infarction patients.

HRV measurements provide information on stress tolerance or rather proficiency function. Enough great variability seems to be an indication of health. Reduced HRV can be understood and used as a marker of reduced vagal activity e.g. short term acute stress or long term vagal withdrawal. People with restricted HRV do function only in a narrow range and quickly get the feeling of not being able to cope with greater life challenges. These people develop health problems (like heart diseases, depression, neuropathy, cancer...) in obviously greater percentages than people with enough great HRV.

A reduction of HRV has been reported in several cardiological diseases, such as myocardial infarction, myocardial dysfunction (patients with cardiac failure) and cardiac transplantation (patient with a recent heart transplant), as well as several non-cardiological diseases, such as diabetic neuropathy and tetraplegia. However, practical use of HRV in adult medicine has yet been achieved only in two clinical conditions: Depressed HRV can be used as a predictor of risk after acute myocardial infarction (both time and frequency HRV measures have been used to predict time to death after myocardial infarction, risk of all-cause mortality and sudden cardiac death in patients with structural heart disease) and as an early warning sign of diabetic neuropathy.

Specific interventions are recognised to modify HRV. Some antiarrhythmic drugs associated with increased mortality can reduce HRV. Full-dose atropine or scopolamine (muscarinic receptor blockers) produces parasympathetic blockade and marked diminution of HRV. Low-dose muscarinic receptor blocker has vagotonic influences and is associated with increased HRV. β-Adrenergic blockade increases HRV. Since cardiac mortality is higher among those post myocardial infarction patients who have a more depressed HRV, interventions that augment HRV may be protective against cardiac mortality and sudden cardiac death. Thrombolysis in patients with acute myocardial infarction increases HRV. Exercise training also increases HRV and may accelerate recovery of the physiological sympathovagal interaction. Exercise training in dogs after acute myocardial ischemia also showed an increase in HRV, but also a complete survival after a new ischemic test. Apart from exercise training and stamina sport, a non-pharmacological improvement of HRV also can be achieved by means of psychotherapy treatments that broaden one's horizons for more variety in thinking, acting and experiencing.

Anyway, despite the growing consensus that increases in vagal activity can be beneficial, it is not yet known how vagal activity can improve cardiac electrical stability and provide adequate protection.

There is increasing evidence on the connection between different symptoms and restricted HRV in recent studies on HRV.

Several studies have suggested a link between negative emotions – such as anxiety and hostility – and reduced HRV. Panic disorder patients and depressive patients also have reduced HRV.

At first, the restricted HRV was registered in cardiac patients with depressive mood. Comparison of HRV in depressive myocardial infarction patients with non-depressive myocardial infarction patients showed that all tested HRV parameters (ULF-, VLF-, LF-, HF-Power) were significantly lower in depressive patients (Carney et al. 2001). Similarly, in patients with coronary artery disease HRV was more restricted in patients with lower depression scores (Sheffield et al. 1998).

Further investigations showed that restricted HRV exists regardless of cardiac disease and is rather connected with registered symptoms of depressiveness (Mück-Weymann et al. 2002).

Further, apart from restricted HRV, also less voice variability in depressive persons were found (Garcia-Toro et al. 2000), confirming that variability is not just a feature of heart, but appears to be a life principle.

Moreover, the investigation of HRV changes in healthy students, previously assessed for depressed mood using the Beck Depression Inventory (BDI), in both stressful situation (speech task to defend himself/herself to a police officer after being falsely accused of shoplifting) and under vagus stimulation (placing an 4°C cold ice bag on his/her forehead) also confirmed this observation (Hughes & Stoney 2000). Individuals with higher depressed mood exhibited greater decreases in high-frequency component of heart rate variability (HF) to the speech task and smaller increases in HF to the cold pressor task than individuals with less depressed mood. These results suggest that mildly depressed but otherwise healthy individuals experience altered parasympathetic responses to stressors.

These findings extended the results of previous investigations of parasympathetic stress responses among patients with coronary artery disease and depressed mood to healthy men and woman. Since the men and women in the latest mentioned study were young (mean age 18,7 years) and healthy, the results suggest that altered ANS activity during stressors in depressed individuals is not a function of underlying cardiac disease.

Environmental factors, such as nutrition and air pollution, seem to influence HRV changes too.

Low density lipoprotein (LDL) cholesterol reduction after (two years) treatment with a statin increases HRV in hypercholesterolaemic patients with or without coronary artery disease, proving HRV, thus, to be a useful tool for risk-stratification in patients with hypercholesterolaemia regardless of coronary artery disease (Pehlivanidis et al. 2001).

A slight improvement of HRV was noted to also accompany the gain in weight in teenager girls with anorexia nervosa (Hummel et al. 2001).

Environmental pollution, i.e. inhalation of air particle (2,5 μm or smaller) impairs HRV (Magari et al. 2001).

Since HRV has considerable potential to assess the role of autonomic nervous system fluctuations in normal healthy individuals and in patients with various cardivascular and non-cardiovascular disorders, further HRV studies will enhance our understanding of physiological phenomena, the actions of medications, and disease mechanisms. That is why the use of HRV techniques to explore the role of autonomic nervous system alterations in disease mechanisms, especially those conditions in which sympathovagal factors are thought to play an important role would be nowadays a fertile area of research.

Foetal and neonatal HRV would be an important area of investigations, while, apart from insight into autonomic maturation in the developing foetus, they might provide early information about foetal and neonatal distress and identify those at risk for sudden death syndrome.

4.2. Possible meaning of heart rate variability for psychotherapy

Through phenomenon of heart rate variability, psychotherapists will be even more stimulated: to pay more and more attention to "autonomous" body processes and to regard these as a main correlate for "unconscious" as well as to build up an aimed confidence in "autonomous functioning". Psychotherapists will be more encouraged to interpret the symptoms as an expression of failed co-operation, as helpful signals that provide further confidence in body signals and are not to be "combated".

Psychotherapists could be further motivated to inspire their patients to achieve a better "adaptability" – a greater variety in the behaviour, thinking and experience – also by paying more attention and respect to internal and external "resonance capability" and to provide more space for this capability through, for example, hypnotic interventions (attention guidance, stopping the thoughts). Producing the resonance to the environment with the means of positive feelings (esteem, sympathy, enthusiasm), developing social "Feedback-competencies", as well as inserting fortified "natural" methods for improvement of heart rate variability, such as particularly stamina and endurance sport activities could be also the result of the psychotherapists' inspiration.

The most important would be, not to forget to always regard people as bounded in their multifaceted environment, and therefore to pay attention to the variety of friction losses, and to strive to narrow this friction losses through producing "coherence".

4.3. Heart rate and heart rate variability measurement

A brief overview of time-oriented, statistical and geometric measures in HRV measurement is given in the following Table:

Table 4.1. A brief overview of time-oriented, statistical (A) and geometric measures (B) in HRV measurement

A) Time-oriented (statistical) HRV measures:

- R-R interval / N-N interval – distance between two heart beats;
- N-N interval mean value (ms) – estimate of overall HRV / overall HRV index
- N-N interval median (ms) – overall HRV index
- N-N interval variance (ms) – overall HRV index
- SDNN - standard deviation of all N-N intervals (of all HPDs) (ms) – estimate of overall HRV
- NN50 for adults / NN6.25 for children – number of adjacent N-N interval pairs that deviate more than 50ms / 6.25ms from each other - short-term variation index
- PNN50 for adults / pNN6.25 for children – percentage of intervals that deviate at least 50ms/6,25ms from the precursory interval (%) – short-term variation index, higher values refer to augmented parasympathetic activity
- RMSSD – square root of the square mean values of the sum of all the differences between two adjacent N-N intervals (ms) – short-term variation index, higher values refer to augmented parasympathetic activity
- SDSD – standard deviation of the differences between adjacent N-N intervals (ms) - short-term variation index
- RSA – respiratory sinus arrythmia - the mean of the differences between two consecutive extreme values (2 HPD maxima or 2 HPD minima) (ms) – variation dependant on breathing

B) Geometric HRV measures:

- HRV-triangular-index – the integral of the density distribution (that is the number of all N-N intervals) divided by the maximum of the density distribution – estimate of overall HRV
- TINN - the triangular interpolation of N-N interval histogram - the baseline width of the distribution measured as a base of a triangle approximating the N-N interval distribution

The significance and meaning of the many different HRV measures as well as the potential for incorrect conclusions and for excessive or unfounded extrapolations led the European Society of Cardiology and the North American Society of Pacing and Electrophysiology to constitute a Task Force charged with the responsibility of developing appropriate standards. The specific goals were to 1) standardise the nomenclature and develop definitions of terms; 2) specify standard methods of measurement, 3) define physiological and pathophysiological correlates; 4) describe currently appropriate clinical applications, and 5) identify areas for future research. To achieve these goals, the members of the Task Force were drawn from the fields of mathematics, engineering, physiology, and clinical medicine. The standards of measurement, physiological interpretation and clinical uses of heart rate variability proposed by this Task Force were published in 1996 (Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology 1996).

According to these referring-to-adults propositions, the variations of heart rate in short-term or long-term electrocardiogram recordings may be evaluated by time domain methods and frequency domain methods.

In time domain methods, either the *heart rate at any point in time* or *the intervals* between successive normal complexes are determined. In a continuous EKG record, each QRS complex is detected, each R-peak is detected, and cardiac *R-R intervals or so-called normal-to-normal (NN) intervals* (that is all intervals between adjacent QRS complexes resulting from sinus node depolarisations) or *the instantaneous heart rates* are determined. Simple time domain variables that can be calculated include the mean NN interval, the mean heart rate, the difference between longest and shortest NN interval, the difference between night and day heart, and so on. For the mean heart rate calculation, the time domain of the NN intervals is converted into the time domain of instantaneous heart rate and the mean value for each data section is calculated separately. Other time domain measurements that can be used are variations in instantaneous heart rate secondary to respiration, to Valsalva maneuver or to phenylephrine infusion. These differences can be described as either differences in heart rate or cycle length.

With the use of *statistical methods*, from a series of instantaneous heart rates or cycle intervals, particularly those recorded over longer periods, traditionally 24 hours, more complex statistical time domain measures can be calculated:

a) Those derived from direct measurements of the NN intervals or instantaneous heart rate are *SDNN, SDAN* and *SDNN index*. Standard deviation of the NN intervals (SDNN), that is, the square root of variance and since variance is mathematically equal to total power of spectral analysis, SDNN reflects all the cyclic components responsible for variability in the period of recording. The total variance of HRV increases with the length of analysed recording, that is why it would be inappropriate to compare SDNN measures obtained from recordings of different durations. SDANN is standard deviation of the average NN intervals calculated over short periods, usually 5 minutes as estimate of the changes in heart rate due to cycles longer than 5 minutes. The SDNN index is the mean of the 5-minute standard deviations of NN intervals calculated over 24 hours, which measures variability due to cycles shorter than 5 minutes.

b) From those derived from differences between NN intervals, the most commonly used measures include *RMSSD, NN50 and pNN50*. RMSSD is the square root of the mean squared differences of successive NN intervals, NN50 is the number of interval differences of successive NN intervals greater than 50 ms, and pNN50 is the proportion derived by dividing NN50 by the total number of NN intervals. All of these measurements of short-term variation estimate high-frequency variations in heart rate.

In addition to the statistical methods, also *geometric methods* can be used to evaluate the heart rate variability. For this purpose, the series of NN intervals are converted into geometric pattern such as the sample density distribution of NN interval durations or sample density distribution of differences between adjacent NN intervals, etc. and variability is assessed on the basis of the geometric and/or graphics properties of the resulting pattern. Three general approaches are used in geometric methods: 1) a basic measurement of the geometric pattern (for example, the width of the distribution histogram at the specified level) is converted into the measure of HRV, 2) the geometric pattern is interpolated by a mathematically defined shape (for example, approximation of the distribution histogram by a triangle or approximation of the differential histogram by an exponential curve) and then the parameters of this mathematical shape are used, and 3) the geometric shape is classified into several pattern-based categories (for example, elliptic, linear and triangular shapes) that represent different classes of HRV. *The HRV triangular index measurement* is the integral of the density distribution (that is the number of all NN intervals) divided by the maximum of the density distribution. *The triangular interpolation of NN interval histogram (TINN)* is the baseline width of the distribution measured as a base of a triangle approximating the NN interval distribution. Both these measures express overall HRV measured over 24 hours and are more influenced by the lower than by the higher frequencies. The major disadvantage of the geometric methods is the need for a reasonable number of NN intervals to construct a geometric pattern. In practice, the recordings of at least 20 minutes, but preferably 24 hours should be used to ensure the correct performance of the geometric methods, i.e. the current geometric methods are inappropriate to assess short-term changes in HRV.

In general, since many of the time domain measures of HRV correlate closely with others, the following four measures are recommended for time domain HRV assessment:

1) SDNN (estimate of overall HRV),
2) HRV triangular index (estimate of overall HRV),
3) SDANN (estimate of long-term components of HRV), and
4) RMSSD (estimate of short-term components of HRV).

The methods expressing overall HRV and its long- and short-term components cannot replace each other. The selection of method should correspond to the aim of each particular study. It is inappropriate to compare time domain measures, especially those expressing overall HRV, obtained from recordings of different durations.

Concerning frequency domain methods, various spectral methods can be applied. Power spectral density (PSD) analysis provides the basic information of how variance (power) distributes as a function of frequency. An estimate of the true power spectral density can be obtained by proper mathematical algorithms. Methods for calculation of the PSD may be generally classified as non-parametric and parametric. In most instances, both methods provide comparable results. The most used non-parametric method for the calculation of power spectral density is Fourier-transformation, i.e. its variation fast Fourier-transformation.

Spectral analysis may be used to analyse sequence of NN intervals in short-term recordings of 2 to 5 minutes as well as NN intervals of the entire 24-hour period. Three main spectral components: VLF (very low frequency), LF (low frequency) and HF (high frequency) components can be distinguished in a spectrum calculated from short-term recordings of 2 to 5 minutes. In addition to these components, by the long-term recordings of 24-hour period the result also includes a ULF (ultra low frequency) component Because of the important differences in the interpretation of the results, the spectral analyses of the short-term and long-term electrocardiograms should be always strictly distinguished.

Physiological mechanisms of heart period modulations responsible for LF and HF power components cannot be considered stationary during the 24-hour period. In the analysis of stationary short-term recordings, more experience and theoretical knowledge exist on physiological interpretation of the frequency domain measures compared with the time domain measures derived from the same recordings. On the contrary, many time and frequency domain variables measured over entire 24-hour period are strongly correlated with each other because of both mathematical and physiological relationships. The results of the frequency-domain analysis are equivalent to those of the time domain analysis, which is easier to perform. The currently available time domain methods are predominantly used to assess long-term profile of HRV. The contemporary non-parametric and parametric spectral methods are predominantly used to analyse short-term electrocardiograms.

Suggestion of procedures for testing of commercial equipment designed to measure HRV as well as normal values of standard measures of HRV for adults are given in the appendix of these propositions.

4.4. Heart rate and heart rate variability measurement in infants

Heart rate variability (HRV) represents a very often investigated phenomenon. Nevertheless, due to the very low specificity and sensitivity of HRV-measures, they were so far accepted as diagnostic and prognostic criteria only in some adult cases, such as in diabetic neuropathy and after a heart attack.

The majority of cardiorespiratory parameters is influenced by age, especially in the neonatal period and during the first months of life.

From the initial individual reports of heart rate variability in healthy and sick neonates and infants it was evident that prematurity and poor health are reflected in attenuated heart rate variability as well as that few standard criteria for the analysis of heart rate variability prevent precise comparisons among the various studies (Rosenstock et al. 1999).

Taking into consideration the developmental progress and maturation in infancy and childhood as well as a different fashion of environmental factors influence than in older subjects, the Pediatric Task Force of the German Sleep Society (Deutsche Gesellschaft für Schlaf Medizin - DGSM), consisting of approximately 300 physicians from all sleep centres in Germany, developed polysomnographic standards for infants and children (Wiater & Niewerth 2000).

Standards for performance of polysomnographic studies as well as standards for evaluation of these studies are provided. According to this, the standard evaluation of polysomnographic studies in infants and children includes the parameters of breathing (breathing frequency, breathing patterns, apneas, hypopneas), heart activity (heart rate, bradycardias, tachycardias, heart rhythm, heart rate variability), blood gases and sleep state.

Age dependent reference values for these polysomnographic studies parameters for healthy infants and children (including healthy term small-for-date infants of more than 1950g birth weight) were also established (Niewerth & Wiater 2000). Heart rate is to be determined during quiet (slow-wave sleep). Reference values in percentiles (C5, C10, C25, C50, C75, C90, C95) are given as beat(s) per minute for the following age ranges: –1,5 month, 1,5-3 months, 4-5 months, 6-8 months, 9-12 months and 12-24 months. Concerning these reference values, heart rate for premature born infants (-1,5 month) should be in the range between 120/min and 147/min (C5-C95) with C50 at the 133/min. Heart rate range for the age 1,5-3 months should be between 108/min and 148/min with C50 at 125/min.

Though, recommendations concerning quantification of heart rate variability could yet not be provided at the time, because further scientific efforts on this issue were necessary. Knowledge about physiology and pathophysiology aspects of heart rate variability behaviour in paediatric indications for polysomnography was insufficient (Wiater & Niewerth 2000; Niewerth & Wiater 2000; Patzak et al. 2000).

The very next year, with the respect to the Pediatric Task Force of the German Sleep Society (DGSM) methodology in infants and children, a data base for reference curves of polysomnographic parameters for clinically healthy term infants and children in the first and second year of life (an age range of 1 to 24 months) was created (Schlüter et al. 2001). The reference group of 681 first polygraphic recordings of the 681 clinically healthy term infants and children without symptoms of upper respiratory infection at the time of sleep study was recruited from clinically apparently healthy population brought to polysomnography because of parental anxiety in order to assess their possible risk of Sudden Infant Death Syndrome (SIDS).

Reference curves for 27 polysomnografic parameters including total sleep time, quiet and active sleep, co-ordinated and paradoxical patterns of thoracic and abdominal breathing movements, periodic breathing, frequency of respiratory pauses, frequency, mean and maximal duration of respiratory pauses following a sigh, central, obstructive and mixed respiratory pauses, transcutaneous partial pressure of oxygen and carbon dioxide, oxygen saturation of haemoglobin, and instantaneous heart rate were given.

Total sleep time (TST) was relatively constant with a median of about 6 hours (an artefact of the sleep laboratory environment). Regular breathing movements as equivalent of quiet sleep increased from a median of 24.6% TST in the first month to 56% TST in the second year of life. Correspondingly, irregular breathing movements as equivalent of active sleep decreased. Blood gases were relatively constant with the mean of oxygen saturation above 96%. Minimal and maximal values of instantaneous heart rate decreased with age.

For all studied polysomnographic parameters which do exhibited a normal symmetrical distribution – including total sleep time, quiet and active sleep, oxygen saturation of haemoglobin, as well as minimum and maximum of instantaneous heart rate, standards could be established by the mean value of control subjects and the range from two standard deviations below to two standard deviations above the mean as normal values, and thus, age-related percentile curves are given. This was not the case for some other studied polysomnographic parameters which exhibited asymmetrical distribution.

Regular breathing and heart rate are features of *quiet sleep*, which is regarded as equivalent of *adult deep sleep* (slow wave sleep, NREM 3 and 4).

Irregular breathing and heart rate are features of *active REM sleep* as well as *light sleep*, also referred to as indeterminate sleep or transient sleep, which can be regarded as equivalent of adult NREM 1 and 2 sleep. Thus, active sleep is in accordance with the sum of REM sleep and transient sleep.

Heart rate measurements are influenced by the sampling rate. Beat-to-beat modus produces a larger range between the 5th and 95th percentiles.

More sophisticated information can be obtained by calculation of heart rate variability.

However, very few studies performed on HRV analysis in typical paediatric sleep laboratory indications do not allow a sure assessment of valence of HRV-measures (Patzak et al. 2000). In order to meet requirements for a clinical application of HRV-measures, recommendations for measurement and analysis in paediatric sleep laboratory were recently provide by the German Society for Sleep Research and Sleep Medicine (Patzak et al. 2002) (see Appendix 4.1.). Application of a uniform strategy of data analysis and the reduction of some HRV-parameters in the time and frequency domain should allow to compare measurements of different sleep laboratories as well as to provide reference parameters.

According to these recommendations, one chest derivation of electrocardiogram (EKG) is usually sufficient for a paediatric sleep laboratory examination. QRS complexes with their R-peaks are identified from obtained EKG record and an R-R interval between two QRS complexes is commonly used as heart period (HPD) and the heart rate calculated from this R-R interval is defined as instantaneous heart rate (IHR). The EKG derivation should be qualitatively good with as few as possible disturbances in order to guarantee needed precision in R-R intervals determination and further calculation of HRV-measures, actually to avoid faulty identification and, thus, artificial interpretation and artificial variability. For the computer-aided R-peaks identification and HRV analysis the EKG record have to be digitised. The requests for the time resolution are higher than in adults, which is due to very low HRV by newborns and infants. Standard deviation of heart rate period (HPD) is in 10 (ten) miliseconds area, average difference of two consecutive HPD accounts for just some miliseconds.

R-peaks detection takes place through the hardware and can be proceeding analogue or digital. A one-millisecond precision by R-peaks detection and HPD determination will be demanded in order to avoid negative influence on statistical analyses afterwards.

Since the aim of HRV analysis is to acquire vegetative mediated and not cardiac mediated or artificial heart rate variability, all time series with technical artefacts (technical disturbances that make R-peaks detection wrong or impossible) as well as time series with cardiac arrythmia (extrasystole, for example) should be corrected or excluded from analysis. According to these recommendations, sections with heart rate changes due to vigilance transition and transition from one sleep stage to another should also be excluded from HRV analysis.

The most common HRV-measures are based on statistical procedures in time domain or frequency domain. Heart rate variabilities by premature born babies, newborn babies and infants are described in two main frequency domains: long-wave (period length of 5-50 seconds), i.e. low frequency fluctuations (0,2 –0,02 Hz) and short-wave (0,7-5 seconds) i.e. high frequency fluctuations (1,4-0,2 Hz). Corresponding physiological functions are assigned to heart rate variability in these frequency domains. Thermoregulation, baroreceptor reflex and movements play a role in low frequency domain. The breathing correlated fluctuations of the HRV determine the high frequency domain (2 Hz should be taken as upper limit for the children who are breathing faster i.e. suffer from respiratory system disease). Already after the first six months of life, frequency domains can be divided into three categories. Frequency domains in adolescence and adults are subdivided into three groups: low (0,02-0,05 Hz), middle (>0,05-0,15 Hz) and high (>0,15-0,50 Hz) frequency domain.

The recommended HRV-measures in the time and frequency domain are presented in Table 4.2 (please see the Appendix): The most used HRV-measures in the time domain are SDNN, SD, RMSSD and RSA. SDNN or just *SD (ms) is standard deviation of heart period durations* (HPD, R-R intervals, NN intervals) and it covers the whole heart rate variability. *RMSSD (ms) is average difference of two consecutive heart period durations* (HPD) (square root of the square mean values of all the differences between two adjacent / successive NN intervals) and it includes prevailing breathing correlated high frequency changes of HRV. Also *RSA (ms)* – respiratory sinus arrythmia gives information about the breathing correlated (high frequency) changes of HRV. RSA as HRV-measure is expression of breathing correlated HPD changes i.e. breathing correlated HRV. RSA can be defined as the sum of all HPD between one inspirium and one expirium. RSA corresponds to the *mean of the differences between two consecutive extreme values (HPD maximum and HPD minimum)* i.e. mean value of differences between the lowest and the highest successive value of the NN interval. Significant correlation between HPD and breathing phase exists by healthy infants in 90% of quiet sleep sections, while it seldom appears in active sleep sections.

Spectral analysis methods that allow valuation of particular HRV components can be divided in parametric procedures such as autoregressive models and non-parametric procedures such as Fourier-transformation, particularly its variation Fast Fourier-transformation.

The recommended HRV-measures in the frequency domain are: LF – performance in low frequency domain (0,02-0,2 Hz), HF – performance in high frequency domain (0,2-2,0 Hz) and TP - performance in the whole frequency sprectrum TP (0,02-2,0 Hz). MF – performance in middle frequency domain is used for the children older than six months.

Concerning choice of sections to be analysed, due to addressed disturbances (sigh, activity, apnoea...) and influences (age, sleep stage, length of examined section, number of possible disturbances, registration of different frequency domains) only selected sections of the whole sleep examination can be used for analysis. Data sections of approx. 2 minutes (130 seconds) for young infants can offer a sufficient length for evaluation of low frequency HRV, on one side, and are short enough to be free from disturbances, on the other side. In older infants and children, longer sections can be free from disturbances. The data section length plays an important role for the analysis in frequency domain. At least three to five heart frequency oscillation in certain frequency domain should be registered and analysed in order to give a proper statement about expression of HRV in that frequency domain.

Except for these recommendations, since reference ranges for infants and children are not yet available, German Society for Sleep Research and Sleep Medicine contributed development of reference ranges for infants and children by giving some orienting values of recommended HRV-measures for infants from birth till the age of six months of life – measurements of HRV were done on the first day of life in 16 in healthy term eutrophic newborns, without complications during the pregnancy, birth and in postanatal adaptation. Measurements were repeated at the age of 3, 5, 7, 10, 14, 21, 28, 60, 90, 120, 150 and 180 days of life. These age dependent reference ranges data are given in percentile (10, 50 and 90 percentile).

Thereby the following protocol, data processing and data analysis were performed:

Protocol: Measurements were performed during 1-2 hours of infant sleep in the evening between 8-11 p.m., 30-60 minutes after the last feeding, in an air conditioned room with room temperature of 23-25°C and low noise level. Infant's motoric activities such as eye movements, mouth movements, body movements and sighs were verbalised and parallel saved - they served later on as markers for the certain sleep state in the given measurement section. For differentiation of quiet from active sleep the motoric criteria according to Prechtl (Prechtl 1974) were used. Closed eyes, absense of apnoea, regular breathing, occasional convulsions, and lack of eye movements or rhythmic mouth movements marked the quiet sleep phase. The active sleep was present if the eyes were closed, breathing irregular, higher breathing rate, apnoea and breathing correlated transient heart rate fluctuations present as well as fast eye movements and coarse body movements.

Data processing: The recorded data were off line digitised. The R-peaks detection was performed with the precision of 1 ms and these signals were saved parallel to breathing signals as time sections of heart period duration (HPD). Several sections of 130 seconds duration for the quiet as well as for the active sleep were obtained with the exclusion of falling asleep phases and transition phases such as sighs, convulsions etc. from the total measurement period. Correction (the correction algorithm working with interpolation routines) of disturbances was performed for the technical problems and extrasystolia and other cardiac rhythm disorders. Correction was needed in less than 5% for the quiet sleep sections and in less than 10% for the active sleep sections. Thus, data analysis was performed only on error-free HPD time sections.

Data analysis: The time domain parameters (HR, SD, RMSSD, RSA) as well as frequency domain parameters (TP, LF, HF) were calculated. Time section of HPD was transformed in the time section of instantaneous heart rate (IHR) and heart rate mean value for each data section was calculated. Calculation of SD and RMSSD were achieved according to definition Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology (Task Forced of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology 1996). RSA was determined through calculation of average differences between breathing correlated heart rate changes in that section, i.e. between the lowest (minimum) and the next highest (maximum) HPD value in that section.

The results of Patzak et al. indicate greater heart rate variability values combined with lower heart frequency at later infant age (6 months) than in the first days of life (2 days). Their results also point out that there is a great inter-individual variability as well as great intra-individual variability.

The most advanced information about behaviour of heart rate variability in infants are achieved by indicated polysomnographic investigations in paediatric sleep laboratory in infants who had experienced an apparent life-threatening event (ALTE) and who may, thus, be at risk for the Sudden Infant Death syndrome (SIDS). In one such study (Edner et al. 2002) these infants of an age range of 3-20 weeks (average of 11,8 weeks) were stressed with carbon dioxide and the instantaneous heart rate variability response to increased carbon dioxide was investigated. The investigation was performed during quiet sleep before, during and after a carbon dioxide challenge. It showed that ALTE infants responded to carbon dioxide breathing with a significant increase in R-R intervals, i.e. decreases in heart rate (opposite to physiological defence response) leading to conclusion that ALTE infants, particularly ALTE boys have an autonomic dysfunction i.e. lower sympathetic stimulation and/or inhibited vagal withdrawal when stressed with carbon dioxide.

4.5. Heart rate and heart rate variability measurement in premature born infants

Premature birth has been shown to increase the risk for Sudden Infant Death Syndrome (SIDS). Though, a database for reference curves of polysomnographic parameters for pre-term healthy infants (an age range of 24 to 37 weeks) is still not available.

However, heart rate variability of premature infants reaching term was compared to heart rate variability of full-term newborns and the quantitative analysis of heart rate variability taking into account the current behavioural state (please see the next following

Chapter 4.6.) was performed. This sleep state dependent heart rate variability analysis showed that the mean R-R interval was significantly shorter and heart rate variability was lower in premature infants reaching term in all frequency bands (0.02-1 Hz) compared to the heart rate variability of full-term newborns for both quiet and active sleep. After sighs, heart rate acceleration could be observed in full-term newborns in active and quiet sleep, but did not appear in premature infants reaching term (Eiselt et al. 2002). Increased mean heart rate and decreased heart rate variability in premature infants reaching term compared to their full-term counterparts suggest that premature birth and subsequent extrauterine development affect heart rate patterns in both sleep states and do elicit different patterns of heart regulation compared to those in full-term newborns.

4.6. Parallel measurements – arterial oxygen saturation, respiratory rate and breathing patterns

As mentioned, obligatory and additional parameters (Wiater & Niewerth 2000) to be measured in polysomnographic studies as well as indications for paediatric sleep laboratory investigations (Niewerth & Wiater 2000) were given in the recent past and according to them, the standard evaluation of polysomnographic studies in infants and children includes the parameters of breathing (breathing frequency, breathing patterns, apneas, hypopneas), heart activity (heart rate, bradycardias, tachycardias, heart rhythm, heart rate variability), blood gases and sleep state.

Except for the heart rate and heart rate variability in the time and frequency domain measurement, the same polysomnographic device can simultaneously measure also other polysomnographic parameters such as respiratory rate and breathing patterns of abdominal and thoracic movements in sense of regularity and deepness of breathing, as well as arterial oxygen saturation (Schlüter et al. 2001, Patzak et al. 2002). For the further investigations in paediatric sleep laboratory indications also chin (submental) electromyogram and electroencephalogram could be measured by the same polysomnography device.

Breathing frequency is determined during quiet slow wave sleep. Remarkable variations during examination should be noted.

Concerning breathing patterns, phase shift between chest and abdominal breathing movements should be described, and the total duration, expressed as a percentage of total sleep time, should be quantified. Periodic breathing, defined as three or more apnoeic pauses of three or more seconds' duration within periods of normal respiration of twenty seconds or less, also should be expressed as a percentage of total sleep time.

Durations of apneas (period from the end of the last expiration to the onset of the following inspiration) should be noted as well as duration of the longest apnea. Breathing cessation lasting 3 or more seconds should be counted as apnea in infants, and breathing cessation lasting 5 or more seconds should be considered as apnea in children. A differentiation between central, obstructive or mixed apneas is mandatory. Classification of apnoeas by a histogram, divided into 1 second - intervals, is recommended.

Hypopneas, defined by a 50% or greater decrease in the amplitude of breathing signals, compared with the last 10 breaths prior to event also should be noted. Temporary O2-desaturations can indicate hypopneas.

Finally, the influence of breathing (inspiration and expiration) on heart rate variability expressed through respiratory sinus arrythmia (RSA)-value should be described as already previously mentioned.

From blood gases parameters, the baseline values of oxygen saturation during quiet or slow wave sleep must be noted. Desaturations, referring to the beat-to-beat mode, must be quantified within the ranges 90-80%, 80-70% and <70%. The lowest SaO2-value should be noted. Histograms of the SaO2-values during entire examination in 10% intervals are recommended.

Sleep staging involves the evaluation of the electroencephalogram, the electrooculogram as well as behavioural observations. Total sleep time and sleep stages must be quantified. Arousals must be described. A sleep profile must be available. Sleep stage-related evaluations of the breathing patterns, apneas/hypopneas, bradycardias/tachicardias and blood gases changes are recommended.

4.7. Parallel clinical observations - behavioural states according to Prechtl

Numerous early studies on heart rate variability in healthy and sick neonates and infants have shown that both time- and frequency-domain HRV depend on the behavioural state of the infant (Rosenstock et al. 1999).

A circadian (in 24-hour rhythm) variation in heart rate and HRV also was identified. Analysis of 24-hour EKG recordings obtained from 57 healthy infants and children, aged 2 months to 15 years, showed a significant circadian variation in heart rate and HRV, characterised by a rise during sleep. However, this circadian rhythm was not obvious in early infancy, due to daytime sleep episodes. The appearance of circadian rhythm was associated with sleep maturation, confirming, thus, a progressive maturation of the autonomic nervous system and supporting the hypothesis that the organisation of sleep, associated with sympathetic withdrawal, is responsible for circadian rhythms (Massin et al. 2000). For this observation, it appears to be even more important to relate the HRV-parameters in the time and frequency domain with the current behavioural state of an infant.

When a human infant is watched in his/her usual environment over a prolonged period of time, he/she not only displays a wide variety of specific behaviour patterns in response to environmental stimuli, but also shows prolonged and characteristic epochs of stable behaviour. Because of the relative stability of these behavioural characteristics over time they have been called “behavioural states”. The concept of behavioural states in young infants has, thus, been used as a descriptive categorisation of behaviour. On the other hand, since distinct brain mechanisms are specific to the descriptive behaviour categories (states), the states must not only be considered as a descriptive behavioural classification, but as distinct modes of brain activity as well. Therefore, the concept of behavioural states in young infants is also used in another connotation - as an explanation of brain mechanisms, which modify the responsiveness of the infant. Behavioural states are distinct and qualitatively different conditions; each of them is considered as particular modes of nervous activity.

There was a tendency to use an interpretative terminology for the state descriptions such as “level of arousal”, “vigilance”, “level of consciousness”, “deep” and “light” sleep. Wolff (Wolff 1959) started with distinguishing between two sleep patterns on the basis of regular and irregular respiration, added drowsiness, alert inactivity, alert activity and crying as further conditions. Prechtl followed Wolff by employing the regularity of respiration as a differentiating criterion. Other criteria were open or closed eyes, movements of head and limbs and finally vocalisations. Based on these criteria, five different behavioural states can be distinguished in newborn infants (Prechtl 1974; 1992):

State 1 - eyes closed, regular respiration, no gross movements except startles;

State 2 - eyes closed, irregular respiration, small movements and incidental gross movements;

State 3 - eyes open, fairly regular respiration, no movements;

State 4 - eyes open, irregular respiration, continuous gross movements;

State 5 – eyes open or closed, irregular respiration, vocalisation (crying or fussing).

These states are purely descriptive. Furthermore, they are mutually exclusive and qualitatively different constellations, and discontinuous i.e. separated from each other by short transitions. These criteria are continually present during the states. Transitory events superimposed on these constellations such as startles, brief bouts of gross movements, rhythmical mouthing movements etc. were purposely not made a part of definition. Additional criteria would not improve the definition of these states but would rather lead to other state categories or to conditions, which would not be covered by all criteria. Thereby, all other conditions which seem to be undefined have to be accepted as transitions. Only changes lasting three minutes or longer are accepted as a new state. Wolff's category of drowsiness – a condition with repeated short times in opening and closing of the eye lids - is therefore rather a transition (from state 3 or 4 into state 2) than a separate state.

A description of the other physiological variables, usually simultaneously recorded in full term babies as well as of the transient events observed during each state follows:

State 1 – quiet sleep - A state 1 epoch begins when the respiration becomes regular in an infant who keeps his eyes closed. Sighs or apnoeic spells may occur. Marked respiration irregularity are always transient and connected with gross motor activity in the form of startles. The overall breathing rate is about 30-40/min. The heart rate is similarly regular and relatively slow 90-110/min, but jumps to 120-140/min during startles, followed by rebound bradycardia. Eye movements under the closed eyelids are not observed, neither are slow eye movements (SEMs) nor rapid eye movements (REMs) recorded by the electro-oculogram. The infant remains in rather stable posture during this state and there is a rather steady tonic activity in many muscles (antigravity response). Occasionally a clonus, a burst of rhythmical mouthing movements or startles can occur.

State 2 – active sleep - A state 2 nearly always starts with a startle or gross movement or at least with a sigh, if this state follows a state 1 epoch. An onset after a state 3 is less marked, the baby simply shuts his eyes and continues with irregular respiration. The respiration is generally faster than in state 1, sometimes highly irregular, apnoeic spells may occur. Heart rate is also irregular – varies within a wide range. REMs occur 2-4 min after the onset of the state 2, preceded by SEMs, which start within 10-30 seconds. Many different types of motility can be observed during state 2: startles are less forceful and in lower incidence than in state 1, small twitches are common in the face, hands and feet, grimaces and smiles can be seen occasionally, rhythmical mouthing is more rarely seen than during state 1.

State 3 – awake - This state is present when the baby lies still (e.g. no movements) and keeps his/her eyes open. Most of the time the infant scans the environment with rapid eye movements, although there may be moments of staring. The baby maintains a posture through tonic muscle activity. State 3 epochs very often (but not always) follow a feed or an activity phase (state 4). It has the shortest duration of all states. This is the optimal state for the neurological assessment of the newborn to be performed.

State 4 – activity phase – The infant has his eyes open and moves his arms, legs, and head. The activity fluctuates and spurts of gross movements alternate with periods of small movements. Eye movements are also present. Respiration and heart beat are grossly irregular especially during gross movements of the infant.

State 5 – vocalisation or crying - The main characteristic of state 5 is a communications signal in form of crying or vocalisation. When an infant is crying, there is a high tonic activity in all muscles, but kicking or writhing movements also are common. The heart rate is high, the respiration pattern is specific during crying, and eyes are either open or closed. Eye movements are usually absent.

In the undisturbed neonate, an epoch of state 1 is mostly followed by a state 2 epoch, which on its turn is followed by another state epoch 1, or more rarely, by a state 3 or 4. On the other hand, transition from state 1 to state 5 is only seen during the first day of life, but hardly occurs in healthy infants on later days. When infants fall asleep, they almost go from a state 3 or 4 into state 2 epoch, but rarely, go directly into a state 1 epoch.

Transitions from state 1 into 2 are rapid and accompanied by a gross movement. The switchover from state 2 into state 1 takes more time and is sometimes unstable. Although respiration becomes regular and movements cease, after a minute or so state 2 may return and continue for several minutes, followed by a new and now successful transition into the state 1 epoch. In the healthy full-term neonate, nearly all transitions cover up to 3 minutes and longer transitions are rare. At ages younger than 36 weeks in foetuses and preterm infants transitions last longer and it is not meaningful to speak of states, rather episodes that fit state criteria and are called coincidental, and all other parts are called non-coincidental.

States also differ from each other in response intensity to different sensory stimuli. Responses to proprioceptive stimuli (tendon tap or short vibration) are of moderate intensity during state 3, are virtually absent during state 2, but are exaggerated with short clonic activity during state 1. Exteroceptive skin responses (tactile or mild pressure) are practically absent during state 1, but mostly present during state 2 and 3. Biologically important protective responses to nociceptive stimuli (tickling) are present at any time and in any state.

Auditory responses to well-defined artificial and natural stimuli have usually been found to be absent during state 1, consistently present but weak during state 2, and only fully present in state 3. This input-output state relation has also been found in the foetus.

Organisation of behavioural states: Behavioural states have a certain duration that is different for each state. In the neonate, the duration of state 1 is about 20 minutes, state 2 is about 30 to 40 minutes, and state 3 lasts usually only a few minutes. The durations of states 4 and 5 are very often variable, dependent on the environmental condition and on the individual characteristics of the infant. If the distribution of states is measured in percentage of time spent in one or another state, it is of crucial importance that the sample time is sufficiently long – two hours is minimum. The main reason for this is the large intraindividual and interindividual variability of the state sequences and their duration. The percentage of state distributions in neonates is age dependent. The prenatally in the foetus present state distribution seems to be disrupted on the first day of extrauterine life and stabilises only several days after. The values seen after several days are very close to those values found in foetuses before birth: about 35% will be spent in state 1, about 53% in state 2, and the rest approx. 10% in all other states together. The position can have an influence on the state distribution: there is more wakefulness in supine than in prone position.

Quantitative description of states can be obtained when monitoring of states is carried out over sufficiently long periods. Reliable quantitative description can provide an important insight into the organisation and regulation of neonatal behaviour. Single sleep cycles are too inconsistent within the same individual, and are moreover modified by environmental conditions and the metabolic and circulatory effects of food intake.

The prenatally present state cycles of the foetus seem to be disrupted after birth, when the newborn adapts to the conditions of his new environment. Furthermore, state cycles differ on the first day after birth from those before and after.

State cycles differ also according to different pathological conditions in neonatal period – infants with Down’s syndrome are more awake at the expense of state 2, infants with hyperbilirubinaemia are less awake and have prolonged state 2 (active sleep) epochs, but spend only slightly more time in state 1 and state 2 (do have more transitions), while in high-risk infants who received medications the increase of state 1 (quiet sleep) can be observed.

Chapter five

Hearing ability

5.1. Otoacoustic emissions

Otoacoustic emissions are all sound signals generated in the inner ear and emitted via the middle ear in the outer auditory canal. They are considered to be epiphenomena and by-products of the activity of the outer hair cells of cochlea. They appear to be generated by microscopic movements of motile elements of outer hair cells of organ of Corti in cochlear duct.

Otoacoustic emissions (OAEs) can be spontaneous (spontaneous otoacoustic emissions - SOAEs), present without any influence of a stimulus, and evoked otoacoustic emissions, which occur only after an acoustic stimulus as an echo response (re-emission), called also transitory otoacoustic emissions (TEOAEs). For clinical use, only the latter are of importance, usually called simply OAEs.

OAEs occur only in a normal cochlea with normal hearing. If there is damage to the outer hair cells producing mild hearing loss, then OAEs are not evoked. Thus, OAEs serve as an evidence of intact inner ear function (outer hair cells), i.e. evidence of normal hearing ability. A good rule of thumb is that OAEs are present if hearing is 35 dB or better. They provide information on the wide frequency range from 1000 Hz to 4000 Hz. OAEs only provide information about the activity of cochlea, and do not assess the status of the auditory pathway. Since the OAEs evidence depends crucially on an intact sound conduction, it is important for neonatal measurements to notice that the presence of fluid in middle ear can limit the validity of measurement.

OAEs enable an objective inner ear function examination independent of vigilance and cooperation of the patient. They are most appropriate for use in difficult-to-test patients such as newborn infants, young children and developmentally delayed populations. OAEs have proved to be a very good screening tool for hearing loss/failure for newborn infants, already older than 24 hours, and are nowadays incorporated into most neonatal screening programmes. As cochlea (inner ear) is morphologically mature and functional already in 24th week of pregnancy, the OAEs can be evoked and OAE test can be successfully performed also in premature born infants (OAEs amplitude and frequency rising with postconceptional age) (Birnholtz & Benaceraff 1983; Brienesse et al. 1996). Therefore, and for the fact that hearing disorders occur with an incidence of 1-3% in risk-children and high-risk-children, to which premature infants belong (Hoth & Lenarz 1997), the hearing screening measurements take place as a part of routine diagnostics also in this population of newborn babies.

Having in mind that speech development and social development in general depend heavily upon hearing, discovering hearing disorders at an early age is of great importance.

5.2. Hearing ability test - otoacoustic emissions test

OAEs are measured by presenting a series of very brief acoustic stimuli (clicks), to the ear through a probe that is inserted in the outer third of the auditory canal. The probe of a correct size / access form (the probe should caulk the auditory canal in order to measure the sound pressure correctly) should be directed to *membrana tympani* i.e. inner ear. The probe contains a loudspeaker that generates clicks (wide range frequency clicks) and a microphone that measures the resulting OAEs that are produced in the cochlea and are then reflected back through the middle ear into the outer auditory canal. The resulting sound that is picked up by the microphones is digitised and processed by specially designed hardware and software. The very low-level OAEs are differentiated by the software from both the background noise and from the contamination of the evoking clicks. Anyway one should try to minimise the background noise. The validity of measurement can be raised through two independent but in the same terms carried out measurements.

If the measurement is realisable, but the OAEs can not be detected, it corresponds to a hearing loss and further examinations are needed. Hearing loss of about 20-30 dB is a threshold value for an ear-replacement.

The OAE measurement serves as a quickly feasible, non-invasive and reliable method for a hearing ability test.

Chapter six

Parental adjustment to parenting. Parental stress, parental competence and functionality of the family. Family assessment tools

6.1. Parental adjustment to parenting and "birth of the family"

As previously mentioned (please see Chapter 3, especially 3.3.) the parent-infant relationship is, nowadays, interpreted as an interaction in which both partners influence each other mutually and they change themselves steady through this influence and each response of one partner is at the same time the stimulus for another (Papoušek 1979). In addition to the infant's social capacities for dyadic two-person and triadic two-person-plus-object interactions, an infant also has social capacities for triangular, three person interactions and formation of a triadic alliance (Frascarolo et al. 1996; Fivaz-Depeursinge & Corboz-Warnery 2001). An infant has the capacity to handle triangular interactions and share his/her affects with two parents. This capacity can be recruited both in functional and problematic alliances (Fivaz-Depeursinge et al. 2005).

Both mother and father have the same intuitive parenting competence and behaviours at their disposal and are important for the optimal development of the child (Fernald et al. 1989). According to the current point of view, the physical presence of the father from the very beginning plays an important role for the mental development of the child (von Klitzing 1998).

Transition to parenting and parenting usually begin well before the birth of the child. Parental inner representations about their parental figures start already with the desire to have a child, than develop through conscious or unconscious fantasies before and after the conception, develop further during the pregnancy and shape continuously the adjustment of the parents-to-be to parenting. The pregnancy represents thus the phase of psychological preparation for parenting. In the view of transition to parenting the inner mental and emotional changes take place as well as changes in the partnership. In the late pregnancy, these changes are so advanced, so that they are immune even against the birth of a real child which could have the potential destabilising character (von Klitzing 1994; Bruschweiler-Stern 1998). From the psychoanalytical point of view, adjustment to parenting could be considered as an identity changing initiation process (Janus 1994). Adjustment to parenting means for the parental relationship, especially with the first child, a transition from a two-person-relationship to a three-person-relationship, from a dyad to a triad. Along with this interpersonal transition, an intrapsychic process, so called triangulation takes part. This describes an ability of a human being to let a third person in the already existing relationship and/or to integrate it (von Klitzing 1994).

This ability of parents to form triad relationships is deciding for the child's development (von Klitzing 1994; Fivaz-Depeursinge et al. 2005). There is a strong connection between the adjustment of the mother and father to parenting and their later interaction with their infant. The way the father, not only the mother, shapes the relationship to his infant has an influence on infant development from the very beginning (von Klitzing 1998). The powers of imagination and fantasy of both mother and father, that is their inner representations of their parental figures before the birth of the baby, of the relationship before and after the birth of the child, and the very real parental relationship as well, have an important influence on the triadic mother-father-infant interaction, on the interaction behaviour of the baby and early infant development (von Klitzing 1998; von Klitzing et al. 1996).

The birth of the first child is simultaneously the „birth of the family". Moreover, as one of the family life cycle phases, the transition to the parenting phase is the most lively and dynamic phase in the development of one family (Adler et al. 1994; Frevert et al. 1996), due to numerous changes that characterise this phase. In addition to an adaptation of a couple to pregnancy, an acceptance of parenting and adjustment to it, preparation for the parental role, the most dynamic family life cycle phase is accompanied with very intensive changes from the family aspect (family therapy) point of view:

First, concerning the transition from dyad to triad the child functions to both bind and separate the parents. The formation of a triadic relationship is under the influence of unconscious parental fears and expectations. The functional relationship pattern between the parents and the infant will be important for the development of appropriate attachment security and the exploration behaviour of the child.

Second, by the adjustment to parenting and takeover of the parental role, the internalised object-relationships will be activated with reciprocal roles. Affect-charged memories on own parents go along with the relationship with own child. A reactivation of unresolved conflicts with own origin family can appear.

Third, a massive impairment of the quality of parental relationship appears to be inevitable, whereby the negative impact could be even more increase with an unexpected difficult temperament of the newborn child. The distribution of tasks and functions (roles) between partners need to be reconsidered and negotiated again. The expectations about engagement can be disappointed. Changes in sex life and behaviour of a couple can occur.

6.2. Adjustment to parenting by premature birth. Influence of parental stress, parental competence and functionality of the family

Different factors could influence parental adjustment to parenting, especially in terms of premature birth. Prematurity can be a challenge for parenting in several aspects.

The adjustment to parenting and early parenting by premature birth are, due to the shortness of pregnancy and therefore shortness of psychological preparation for parenting, disturbed (please see Chapter 3.5.). There is a need to provide a safe holding environment, from an experienced, accepting and warm person, who respects the timing of the woman who has been thrown into the mother role, but is not ready to take it on, in order to support and gently accompany an accelerated metamorphosis of parents-to-be into parents (Bruschweiler-Stern 1998).

Parental stress could be another factor that could interfere with optimal adjustment to parenting. Ongoing fine tuning to infants needs is required for the ongoing regulation of intuitive parenting and therefore for an optimal parent-infant interaction and an infant’s optimal development (as described in Chapter 3.3.). This can be complicated in the case of premature birth, since the premature infant’s behavioural cues are less pronounced, and responsiveness to the signals of infant’s interactional readiness as well as to the first signs of distress could easily be misinterpreted. Parental current stress due to solely prematurity or due to other concurrent life happenings could interfere with the parental ability to interact finely attuned to the infant’s needs, could interfere with parental capacities and competences, and could thus severely limit a parent’s ability for fine tuning.

There is increasing evidence that parental stress could have a negative influence on an infant’s development. A recent review (Rich-Edwards & Grizzard 2005) points out that chronic stress can be a prepregnancy primer for preterm delivery. Chronic stress, especially lifelong exposure to psychosocial stressors (like poverty, racism and lack of neighbourhood safety) may shape the reproductive health of girls and young women, thus “priming” the likelihood of poor pregnancy outcomes even before the pregnancy is conceived. It may be helpful to consider poor pregnancy outcomes as part of chronic disease processes. The female reproductive axis may be vulnerable to chronic stress with poor pregnancy outcomes as a result. In this sense, preterm and low birth weight delivery could be considered as a chronic disease messenger. Maternal endocrine and immune systems that are shaped by chronic stressors before conception may create particular vulnerabilities to pregnancy complications and preterm delivery. The physiologic stress of pregnancy often reveals latent tendencies toward future chronic disease. The delivery of a preterm or low birth weight infant predicts a higher risk of future cardiovascular disease.

New data provide evidence that maternal emotional stress in pregnancy can predict infant affective reactivity to novelty (novel situations/experiences). Maternal emotional stress in pregnancy is significantly associated with infant early distress to novel stimuli, which is an important predictor of long-term emotional development in childhood and adolescence (Möhler et al. 2006). Precisely, the infants’ affective reactivity to novelty will be decreased when the mother had emotional stress during pregnancy, higher education and already has at least two older children. Infants classified as low reactive in the face of novelty tend to be inhibited with low latency approach behaviour; they typically develop into extraverted, novelty seeking children, more often showing signs of externalising problems and impulsivity than inhibited children (Kagan & Snidman 1991).

Moreover, the individual perinatal stress experience of mother and/or father, i.e. stressful or traumatic parental experience of birth, even and often regardless of real medical complications, may interfere with adjustment to parenting and contribute to the development of postpartum psychological disturbances in parents which may further lead to dysfunctional parent-child interactions and affect the infant’s affect regulation and attachment processes. This pathogenetic mechanism has hardly/scarcely been considered up to nowadays (Thiel-Bonney & Cierpka 2004). The parental response to premature birth mediates the risk for later adverse outcomes such as sleeping and feeding problems related to prematurity. The intensity of the post-traumatic stress reactions of the parents is an important predictor of these problems (Pierrehumbert et al. 2003). Maternal traumatic experience related to premature birth has potential long-lasting influence on mother-infant interaction, since mothers of high-risk infants, as well as mothers that had experienced traumatic stress in the perinatal period, show less sensitivity and are more controlling during play at 6 months of infant’s age, whereby the interactional behaviour of the preterm infant correlates with maternal traumatic stress (Muller-Nix et al. 2004).

Finally, the birth of a premature infant and its hospital stay in the NICU is stressful for family members. The threat to the child's survival and invasive medical procedures can be very traumatic for the parents. They must adjust to unfamiliar surroundings in the NICU, learn new vocabularies, cope with the infant's uncertain survival and outcome, maintain vigilance at the NICU, and eventually assume care for a recovering infant at home and parenting the preterm infant upon hospital discharge (Bakewell-Sachs & Gennaro 2004; Swartz 2005). It is well known that acute psychological stressors increase cortisol levels. Effects of stress on cortisol levels vary, however, widely across tasks: Tasks containing both uncontrollable and social-evaluative elements (task performance could be negatively judged by others, for example) are associated with the largest cortisol and adrenocorticotropin hormone changes and the longest times to recovery (Dickerson & Kemeny 2004). Therefore, since containing both uncontrollable and social-evaluative elements, premature birth and care for premature born infant could be concerned to be associated with the large cortisol and adrenocorticotropin hormone changes and the long recovery time. Previous distressing experiences through complications of previous pregnancies and deliveries, handicaps, chronic disorders and behaviour problems of siblings negatively influence the perception of the infant's health. The mother's mood is associated with the atmosphere of the intensive care unit, partnership resources and social support outside the family (Ganseforth et al. 2002). As both biological and psychosocial factors do have an effect on the mother's experience, it is necessary to evaluate previous maternal experiences and coping resources and offer practical counselling for the mothers to optimise the clinical care.

Quite contrary to the negative influence of parental stress, some other factors could have protective influence on parental adjustment to parenting and early parenting. Parental competence could be one of protective factors. Unfortunately, premature birth evokes feelings of incompetence and failure. The feeling of incompetence is confirmed by the fact that specialists and sophisticated equipment are needed to care for her infant. Even without existence of any maternal psychopathology, mothers of premature born infants easily suffer from lack of self-confidence, feelings of incompetence and helplessness, which, in addition to the immaturity of infant's cues, affect parent-infant interaction. Parental intuitive support in parent-infant interaction with a premature baby can be compromised, therefore, solely due to prematurity (as described in Chapter 3.5.).

The functionality of the family could be another important resource for parental mutual support in the case of premature birth as a challenging situation. The process of adaptation to the new situation and understanding between partners with the distribution of new tasks and roles can be easier and facilitated if there is an openness between the partners for the needs of the other and if emotional exchange is an essential part of their relationship (Frevert et al. 1996). Support by other family members could also be a protective factor in parental premature adjustment to parenting.

Increasing our understanding of maternal stress could help ameliorate some of the deleterious effects that persistently elevated levels of stress can produce. Supporting (future) parents in coping with stress could improve the health and development of their child. There is much less evidence about the influence of protective factors like parental competence and functionality of the family on parenting a premature infant. Encouraging results of some family-based interventions in neonatal intensive care unit developed in order to support parental adjustment to parenting are presented here.

Health care professionals could help a premature mother a great deal by recognising her vulnerability and helping her to connect with her infant. Early clinical management and emotional care for mothers and infants based on the principles of birth as an opportunity for reorganisation and changes; meeting of the mothers' "real" and "imagined" infants; appreciation of the infant's strengths; and development of a therapeutic alliance with the mother, whereby creation of a safe holding environment for the mother, especially mothers of preterm infants has been shown to be very encouraging (Bruschweiler-Stern 1998).

A trauma-preventive psychological intervention programme for parents of premature infants offered in the form of a structured psychological intervention in the first days after birth can significantly lower levels of symptomatic response to the traumatic stressor "premature birth" and thus reduce the symptoms of traumatisation related to premature birth (Jotzo & Poets 2005).

As already mentioned (please see Chapter 1), mothers practicing kangaroo care feel more competent in stressful situations in the NICU (Tessier et al. 1998). Adding social support as an integral component of Kangaroo care was suggested, since meeting the social support needs of the mother is important for her own mental and physical health and well-being, but it also helps her meet social and developmental needs of her infant (Logsdon & Davis 1998).

The sensitivity of the mothers to their premature infants can affect the mother-infant relationship. The assessment of maternal competence and sensitivity to premature infants in the NICU (The Boston City Hospital Assessment of Parental Sensitivity) showed that the assessment of maternal behaviour in the NICU can predict the mother-infant relationship when infant is eight months old (Zahr & Cole 1991), confirming that interactional styles arising in the newborn period tend to persist throughout childhood. Though, the interactional styles could be influenced by an intervention focusing on maternal recognition of infant cues, social stimulation of the infant and family integration. Developmental care may promote better family, infant and child outcomes by both reducing neonatal stress and its neurobiological sequelae, and fostering an appropriate interactional relationship between mother and infant (Whitfield 2003). Preterm infants who received developmentally supportive family-centred care according to NIDCAP® demonstrated fewer behavioural stress cues (baseline, activity and post-activity stress cues) and/or more effective resource utilisation (Byers et al. 2006).

Family-based interventions in the neonatal intensive care unit may change parental knowledge and behaviours and decrease stress. It was shown that participation in either intervention group (one intervention: demonstration of infant reflexes, attention, motor skills and sleep-wake states; the other intervention: viewed educational material) vs. informal discussion as a control situation may enhance knowledge, sensitivity and contingency, and decrease stress. Mothers in both intervention groups evidenced greater knowledge (Knowledge of Preterm Infant Behavioural Scale) and had more contingent and more sensitive interactions with their infants (Nursing Child Assessment Feeding Scale), although all mothers reported stress scores above norms (Parenting stress index) (Browne & Talmi 2005).

6.3. Family assessment tools used in this study for psychosomatic appraisal of parental stress, parental competence and functionality of the family

Parental current stress experience and coping with it: An instrument “Parental stress questionnaire” developed by Vonderlin (Vonderlin 1999), on the basis of research results describing how parents react to premature labour (Pederson et al. 1987) and already used in the studies concerning parental burden due to the premature birth and coping with it

(Vonderlin 1999; Jotzo 2004), was used to assess the actual stress experience of the parents of premature born infants in a neonatal intensive care unit.

This stress assessment scale takes into account four important aspects: “Actual threat”, “Future of the child”, “Internal expectancy of control” and “Support from partner”. Both aspects “actual threat” and “future of the child” are directed to the characteristics of stressors and can be, thus, considered as “primary appraisal” in the sense of Lazarus & Folkman (Lazarus & Folkman 1984). The other two aspects “internal expectancy of control” and “support from partner” contain “rating of own resources”, and are, therefore, designed as „secondary appraisal“. Six item were developed for each of the following aspects: “acute threat”, “future of the child“ and „internal expectancy of control“, with four items for the judgement of the „support from partner“. Using the four point scale, ranging from: “it isn’t applicable” to “it is very applicable”, the parents are supposed to answer to what extent is each statement applicable to their own life in the last week. The parental stress questionnaire can be seen in the Appendix (6.1.).

Parental competences with premature infant: The questionnaire on parental competence (“Parental competences questionnaire”) used in this study was developed by Schneewind et al. (Schneewind et al. 1989) and already used for the parental competence assessment for the parents of premature infants in the Heidelberg’s neonatal intensive care unit (NICU) in one study concerning parental burden due to the premature birth and coping with it (Vonderlin 1999).

The questionnaire consists of eight items. For each item, the two extreme poles are verbalised and the scale from 1 to 6 is offered, so that parents are supposed to choose the applicable number on this scale that applies to them. The items address the following aspects: “General competence as mother/father”, “Care competence (putting on a baby‘s nappy, feeding the baby, bathing the baby)”, “Empathy”, “Patience”, “Knowledge about infant’s needs”, “Coping with unfamiliar situations”, “Ability to calm down the child”, and “Ability to set limits”. The parental competence questionnaire can be seen in the Appendix (6.2.).

Functionality of the family: The functionality of the family was measured by the Family Assessment Measure (“Die Familienbögen”), an instrument developed by Cierpka and Frevert (Cierpka & Frevert 1994). The Family Assessment Measure was already used for the appraisal and assessment of family functioning in numerous different studies. This is, however, the very first use of this assessment tool for the premature infants’ families in the neonatal intensive care unit (NICU) setting. The Family Assessment Measure takes into account important dimensions of family functioning. Family functioning dimensions are assessed through the following seven standard scales: “Task accomplishment”, “Role performance”, “Communication”, “Emotionality”, “Affective involvement”, “Control”, “Values and norms”, as well two control scales: “Social desirability”, and “Defence”.

Standard scales have four items each, and control scales have six items each. Using the four point scale, ranging from: “it isn’t applicable” to “it is very applicable”, the parents are supposed to answer to what extent is each statement applicable for their own family.

The sums of the item scores for each scale are “raw” scores. The “raw” scores on these scales are transformed into T-values. The T-values sum has a mean value of 50 +/-10 i.e. the majority of the T-values for clinically psychologically normal families are between 40 and 60. T-values over 60 indicate critical areas. The results of the standard scales have, though, to be always considered with regard to the control scales scores/values. Control scales values under 40 do not assure the validity of the standard scales – they rather indicate impact of other influences (projections, for example). The Family Assessment Measure can be also seen in the Appendix (6.3.).

PART THREE: **STUDY DESIGN**

Chapter seven

Effect of the mother's voice on heart rate and heart rate variability in comparison with the effect of lullaby music

7.1. **Study design**

With the intention to continue further adjustment and accommodation of intensive care unit acoustic stimuli to those that a foetus experiences *in utero,* we created a comparative study design to examine the effects of pleasant auditory stimulation with lullaby music and mother's voice on premature born infant's heart rate and heart rate variability.

The aim/purpose of the study was to investigate:

- if the auditory stimulation in a form of lullaby music has an effect on heart rate and heart rate variability as well as ascertain what kind of an effect;
- if the auditory stimulation in a form of a mother's voice has an effect on heart rate and heart rate variability as well as determine of an effect;
- if there is a difference between the effects of these two pleasant auditory stimulations on heart rate and heart rate variability as well compare the differences;
- if there is a difference in effect between different mothers´ voices, as well as examine what influences this difference – does the family situation, the mother's own stress management or her feelings of affability with her premature born infant have an influence on current quality of the mother's voice and thereby an indirect effect on infant's heart rate and heart rate variability.

7.2. Hypotheses and scientific aim

Based on research contributions in the literature as well as on our own clinical observations we expected that:

- both music and a mother's voice can have a calming effect on an infant;
- mother's voice, even a recorded mother's voice, has a greater effect on an infant than recorded music;

- a mother's voice from a mother who manages her current stress better, who feels more competent in parent-child interactions and who has a more functional family will have the greatest effect.

7.3. Patients and methods

7.3.1. Patients

The experimental study took place at the Clinic for Neonatology, Centre for Medical Care of Children and Adolescents, University of Heidelberg (Klinik für Neonatologie, Zentrum für Kinder- und Jugendmedizin, Universitätsklinikum Heidelberg) under the scientific supervision of Prof. Dr. med. Otwin Linderkamp and at the Institute for Psychosomatic Research and Familytherapy, Centre for Psychosocial Medicine, University of Heidelberg (Institut für Kooperationsforschung und Familientherapie, Zentrum für Psychosoziale Medizin, Universitätsklinikum Heidelberg) under the scientific supervision of Prof. Dr. med. Manfred Cierpka.

Premature infants born in the Perinatal Centre of the Hospital Centre of University of Heidelberg (Perinatalzentrum der Universitäts-Frauenklinik, Universitätsklinikum Heidelberg) and initially treated in the Neonatal Intensive Care Unit of the Perinatal Centre (Intensivstation für Frühgeborenen und kranke Neugeborene in der Frauenklinik - FIPS), birth age of 27-36 gestational weeks, were included in this study. At the age of approximately 4 weeks (corrected age 30-41 gestational weeks), premature infants received the following auditory stimulations:

- Music – lullaby music;
- Mother's voice – recorded own mother's voice reading a favourite fairytale.

Music and the mother's voice were offered via Hi-MD Walkman (SONY®, Japan, MZ-NH 700) with two small loud speakers (SRS-A5, SONY®) in the temperature controlled bed of the infant about 10cm from infant's ears at 55-65 dB. Sound intensity was measured by means of a decibelmeter (Precision Integrating Sound Level Meter Type 2222, Brüel & Kjær – Nærum, Denmark).

Each of the premature infants received both types of auditory stimulation. Auditory stimulation took place between two meals (feedings) in the afternoon or early evening hours once a day on two consecutive days. The order of particularly auditory stimulation for each infant was randomly assigned. A total of 30 infants were investigated. In order to get a basic heart rate and heart rate variability for the premature born infants (control values) as well as to avoid possible interpretation errors, the measurements were also performed without any acoustic stimulation, on a day previous to the start of the acoustic interventions, in 20 of these 30 infants. Therefore, a total of 80 examinations (measurements) were done.

Each of the auditory stimulations lasted for approximately 15 minutes. The total measurement period lasted approximately 45 minutes per day, including 15 minutes of a quiet period before for obtaining the baseline (control values) measures and 15 minutes of quiet period after the auditory stimulation in order to test the possible prolonged effect. Since the measurement took place before, during and after the auditory stimulation, each infant was its own control (control group).

7.3.2. Methods

Reactions of premature born infants on music and their mother’s voice were assessed through an effect of auditory stimulation on heart rate and heart rate variability and compared to the known effects of stress- (activation of sympathetic nervous system, sympathicus) and relaxation- (prevail of parasympathetic nervous system, parasympathicus) situations.

For this purpose, we used a polysomnography device (Twente Medical Systems, Netherlands) which measures simultaneously 1) electrocardiogram for heart rate and heart rate variability in the time and frequency domain, 2) respiratory rate and breathing patterns in the sense of regularity and deepness of breathing, as well as 3) arterial oxygen saturation (Schlüter et al. 2001; Patzak et al. 2002). These parameters were continuously monitored and recorded before, during and after the auditory stimulation. The instrument that was used has a measuring sampling frequency of 1000 samples per second. The data were stored digitally on a hard disc and were reviewed and analysed later (For data management, statistical analysis as well as data interpretation please see the Chapter 8.6.). In order to avoid additional stress for the premature infants for the determination of sleep states we used a computer software programme (Poly5, Inspektor Research Systems, Amsterdam, Netherlands, adapted by J. Brüssau, University Childrens´ Hospital, University of Heidelberg, 2004) instead of chin electromyogram and electroencephalogram (which can also be measured by the same polysomnography device). Parallel to polysomnographic measurements, clinical observations of sleeps states, i.e. behavioural states according to Prechtl (Prechtl 1974) were performed.

Heart rate and heart rate variability were compared concerning the sleep states which were determined with the help of the computer programme as well as with the clinical observed sleep states according to Prechtl.

The possible influence of the current family situation on the mother and the quality of a mother´s voice or that is to say the possible influence of the current family situation on the heart rate and heart rate variability of the premature born infants via mother´s voice was assessed by using psychological questionnaires. Questionnaires concerning parents´ feelings of the current stress experience (Vonderlin 1999, see the Chapter 6.1.) and parents´ competences of affability with their own premature born infant (Schneewind et al. 1989, see the Chapter 6.2.) as well as a questionnaire concerning the functionality of the family (Cierpka & Frevert 1994, see the Chapter 6.3.) were given to both parents.

Chapter eight

Preparation and realisation of the study

8.1. Declaration of parental consent

As soon as premature born infants were judged to be relatively clinically stable, i.e. they only had an isolated occurrence of cardiorespiratory instability, which did not appeared during the measurement periods (data from infants that experienced an occurrence of cardiorespiratory instability during the measurement period were not included into analysis, please see the Chapter 8.6.), a personal conversation with the respective parents was conducted. The purpose of the conversation was to inform the parents about the study, (an information note about the study design (please see Appendix 8.1.) was also given to the parents), to explain the methods and the procedures used in the study, to give the parents the possibility to have their questions answered immediately as well as to obtain written parental consent. The conversation also served as an opportunity to provide parents the psychological questionnaires. Sometimes the questionnaires were given during the assessment days. The conversation took place several days before measurements.

8.2. Recording of auditive stimulation

The auditive stimulation samples were recorded by Hi-MD Walkman (SONY®, Japan, MZ-NH 700) on a Mini Disc (SONY®, MDW80) previous to measurements.

Premature infants received an individual auditory stimulation, i.e. own mother’s voice reading a fairytale of her own choice. Each mother chose her favourite fairytale, whereby mothers were advised to choose a fairytale which lasted approximately 15 minutes (a fairytale was read without repetition in order to avoid frustration). Each mother’s voice was recorded while she was reading the chosen fairytale to her own baby.

A lullaby music melody was recorded from one musical clock and repeated several times in order to last 15 minutes (unfortunately repetition could not be avoided). All the children received the same lullaby melody sample as auditory stimulation.

8.3. Hearing ability test – hearing screening procedure

Otoacoustic emissions based Echo-Screen® device (Fischer-Zoth, Germering, Germany) was used to perform the hearing ability test in premature born infants (for the physiology and clinical use of otoacoustic emissions please see Chapter Five).

A hearing ability (OAE) test was performed prior to the heart rate and heart rate variability measurements as part of the routine neonatal screening procedure. The procedure takes only a few minutes and was performed on both ears late in the evening in order to achieve as quiet a setting as possible.

8.4. Application of measurement device

The usual neonatal intensive care unit monitoring for heart rate, breathing rate and oxygen saturation level was replaced with the mentioned (portable) polysomnography device by replacing the electrode sockets. The measurement took place between two meals (feedings) in the afternoon or early evening hours. In order to avoid additional stress for premature babies, the polysomnography device stayed on the whole time between the two feedings, i.e. for two or three hours.

8.5. Heart rate measurement and recording

The data recording measurement started as soon as the premature infant fell asleep shortly after the meal. The first introductory 15 minutes, termed the „before“ period, were continuously followed by the next 15 minutes, termed the „during“ period, during which the random acoustic stimulation was performed, and in the end continuously followed by the next 15 minute period afterwards, termed the „after“ period.

The electrocardiogram for heart rate and heart rate variability in the time and frequency domain, respiratory rate and breathing patterns in the sense of regularity and deepness of breathing, as well as arterial oxygen saturation were continuously recorded by the mentioned polysomnographic device.

Behavioural state clinical observations according to Prechtl (Prechtl 1974) were also performed during the data recording measurements (measure protocols). State 1 (quiet sleep, light sleep) (please see Chapter four) was determined as quiet sleep, state 2 (active sleep, deep sleep) as active sleep, while state 3 (awake, level of consciousness), state 4 (activity phase, vigilance) and state 5 (vocalisation/crying, level of arousal) were recorded as awake phase. Description of the behavioural state took place every 30 seconds. Each possible necessary intervention as well as a possible alarm signal due to the occurrence of cardiorespiratory instability during measurement was also documented in the measurement protocols.

The following Figure shows a short (30 seconds) recording of non-REM and REM sleep state in one preterm infant from our study:

Figure 8.1. Non-REM sleep section

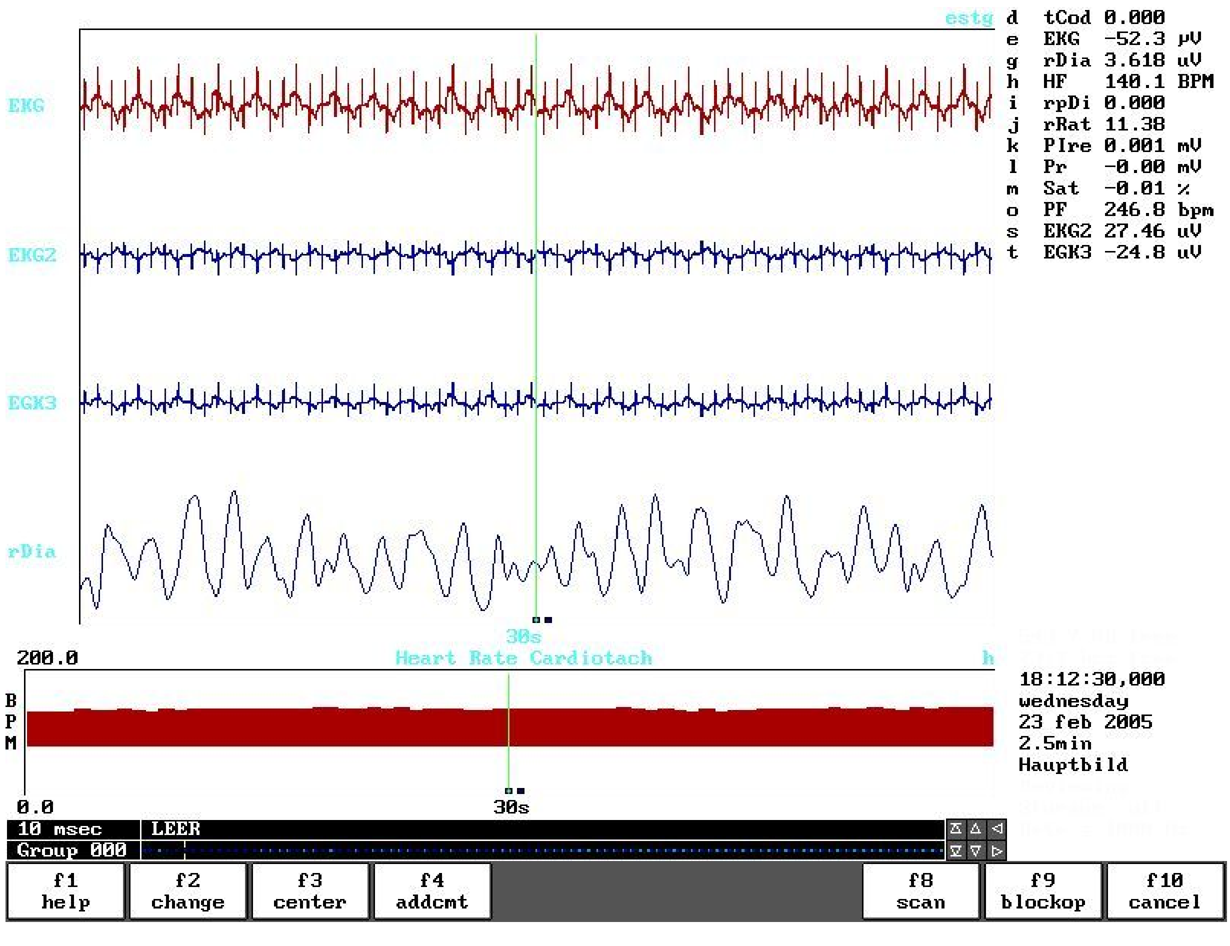
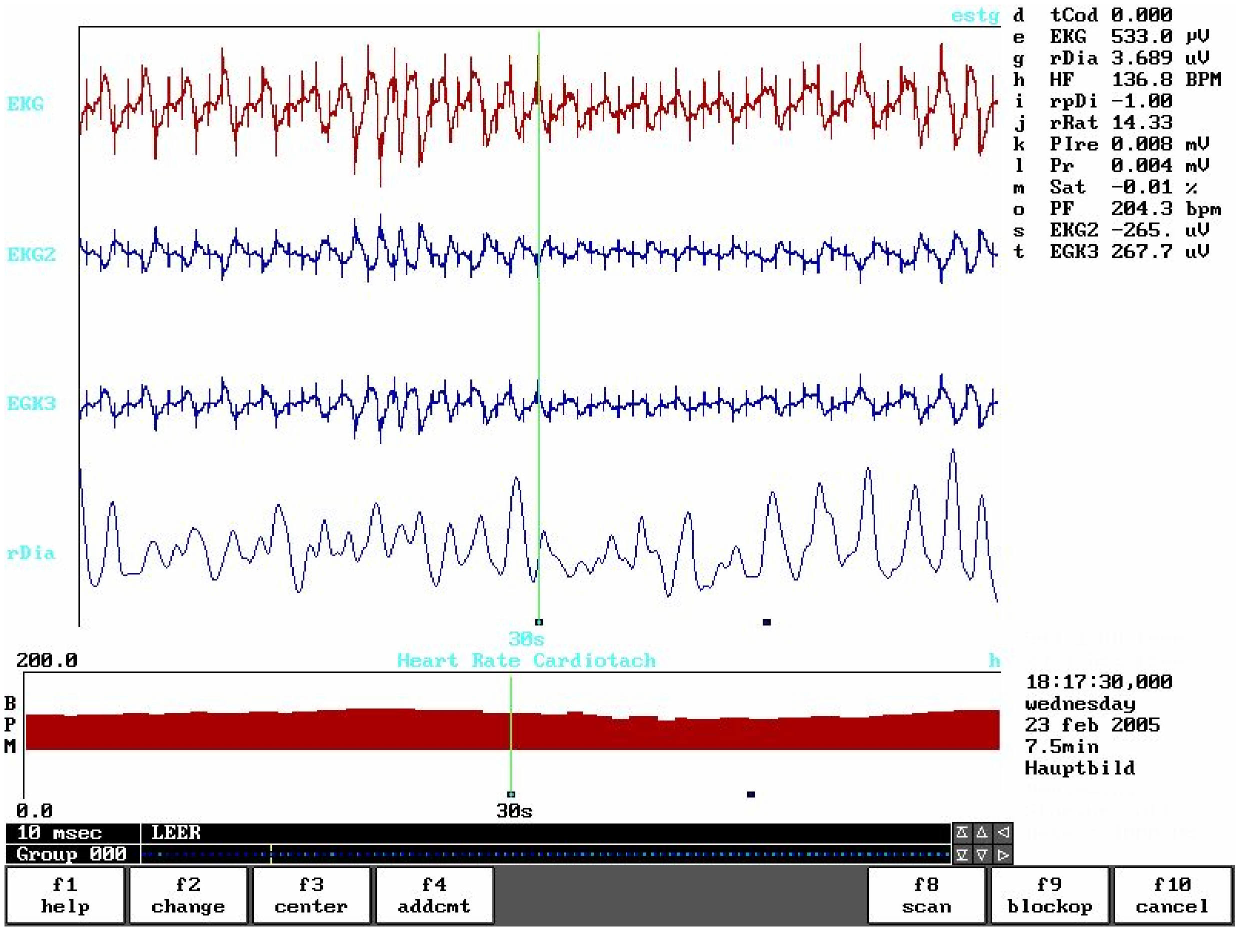


Figure 8.2. REM sleep section



8.6. Data management, statistical analysis and data interpretation

Data management: Digital data (please see Chapter 7.3.2) obtained in the form of continuous electrocardiogram for the heart rate and heart rate variability in the time and frequency domain were further processed by means of computer software programme Poly5 (Inspektor Research Systems, Amsterdam, Netherlands). The R-peaks of each QRS complex were recognised with the precision of 1 to 2 ms and saved parallel to the respiratory signals as a time domain of event moments. Cardiac R-R intervals (R-peak distances, also called NN intervals) were located from this time domain. Useless sections, for example technical disturbances, wake-up reactions, falling asleep, transition phases, etc. were distinguished with the help of graphics and recorded measure protocols, and then excluded. The data from infants that experienced an occurrence of cardiorespiratory instability (bradicardy, apnoea) during the measurement period were excluded from the analysis. The data recorded during the lullaby music measurement period for an infant that developed an episode of transitorial paroximal supraventricular tachicardy an hour after lullaby music was applied, were completely excluded from heart rate variability analyses.

Clinically observed sleep states (quiet sleep, active sleep, awake) were compared to the sleep states determined by the means of a computer programme (non-REM sleep, REM sleep, awake state) and a correlation between these methods was established. Heart rate variability measures of one data section were compared only within the corresponding sleep state.

Statistical analysis: Time-dependent parameters such as mean heart rate, mean NN interval, NN interval median, variance and standard deviation of the NN intervals, the mean difference of two successive NN intervals and respiratory sinus arrythmia were analysed. Simple time domain variables such as mean heart rate, mean NN interval, the difference between longest and shortest NN interval were calculated. For the mean heart rate calculation, the time domain of the NN intervals was converted into the time domain of instantaneous heart rate and the mean value was calculated separately for each data section. More complex statistical time domain measures such as standard deviation of the NN intervals (SDNN) and standard deviation of the average NN intervals (SDANN) were calculated. From interval differences were calculated RMSSD, the square root of the mean squared differences of successive NN intervals, and NN6.25 as well as pNN6.25 which correspond to NN50 and pNN50 at adults, respectively - the number and the proportion of interval differences of successive NN intervals greater than 6.25ms / 50ms. Determination of respiratory sinus arrythmia in the time domain of the NN intervals was achieved through calculation of the mean value of differences between the lowest and the highest successive value of the NN interval, which correlates with breathing, in that data section.

Calculations were achieved according to the definition Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology (Task Forced of the European Society of Cardiology and the North American society of Pacing and Electrophysiology 1996).

According to the recommendations for measurement and analysis in the paediatric sleep laboratory, provided by German Society for Sleep Medicine (Patzak et al. 2002), the following heart rate variability measures were chosen for further analysis:

1) mean NN interval (ms);
2) NN intervals median (ms);

3) variance of NN interval length;
4) standard deviation of NN interval length;
5) pnn 6,25 (%) – the number and the proportion of interval differences of successive NN intervals greater than 6,25 ms, i.e. number of adjacent NN interval pairs that deviate more than 6,25 ms from each other;
6) RMSSD – square root of the square mean values of all the differences between two adjacent/successive NN intervals;
7) SDSD – standard deviation of the differences between adjacent/successive NN intervals; and
8) RSA – respiratory sinus arrythmia - the mean of the differences between two consecutive extreme values (HPD maximum and HPD minimum), i.e. mean value of differences between the lowest and highest successive value of the NN interval.

These heart rate variability measures data were calculated, analysed and evaluated for each section separately, i.e. before, during and after acoustic stimulation, for the control (C) situation, lullaby (L) acoustic stimulation and fairytale (M) acoustic stimulation as well as separately for the non-REM and REM sleep and awake state (Vandeput et al. 2010) (for the variable cod please see Chapter 9.3.).

In order to judge the heart rate variability graphically (Polardiagram), the series of NN intervals were converted into a geometric pattern such as the sample density distribution of NN interval duration and sample density distribution of differences between adjacent NN intervals and variability will be judged on the basis of the geometric and/or graphics properties of the resulting pattern. For this purpose we used interpolation of geometric pattern by a mathematically defined shape – approximation of the differential histogram by an exponential curve. In order to provide the basic information of how variance (power) distributes as a function of frequency, power spectral density analysis was one spectral analysis methods applied. An estimate of the true power spectral density can be obtained by proper mathematical algorithms. For this purpose we used fast Fourier transformation, as a non-parametric method for the calculation of power spectral density. However, the results of the frequency domain measures are not presented here.

For the elaboration of text, pictures, graphics, histograms and statistical analysis, Microsoft Office and SPSS for Windows (Version 11.5 and 12.0), run on the personal computer, were used.

<u>Data interpretation:</u>

The recorded heart rate variability measures data were assessed for the normality of the distribution using the Kolmogorow-Smirnov test (for small samples).

Descriptive statistics and time dependent explorative data analyses (Boxplot diagrams) for the mentioned eight heart rate variability measures were performed.

To examine the association between different auditory stimulation interventions, the analysis of variance (two-way repeated measures ANOVA) for the factor “acoustic stimulation” (C, L, M), for the factor “time” (before, during and after) as well as for the interaction between these two factors (acoustic stimulation and time) with T-tests as appropriate post-hoc tests was performed. Significant differences were assumed if $p<0,05$.

The data were evaluated according to the recommendations for measurement and analysis in the paediatric sleep laboratory provided by "German Society for Sleep Research and Sleep Medicine" (Deutsche Gesellschaft für Schlafforschung und Schlaf Medizin) (Patzak et al. 2002).

8.7. Avoiding possible errors

In order to obtain a basic heart rate and heart rate variability for the premature born infants in the early evening hours and to avoid possible interpretation errors, measurements were also performed between two meals without any acoustic stimulation (control situation).

Possible errors of calculation of standard deviation of the NN intervals (SDNN) and standard deviation of the average NN intervals (SDANN) due to wide data range (especially of a different length) were avoided by expressing the standard deviation as a percentage of the median. The same procedure was performed with the variance.

PART FOUR: **RESULTS AND DISCUSSION OF THE STUDY**

Chapter nine

Results of the study

9.1. Sample characteristics

The study was carried out in a sample of thirty (30) premature infants and their parents recruited over a one year period (from April 2004 till April 2005). The control measurements (please see Chapter 7.3.1) were performed in 20 of them. The HRV data (but not the other data) of one infant that developed paroxismale supraventriculare tachicardy (PSVT) (please see Chapter 8.6) were excluded from further analyses on heart rate variability.

Premature infants that took part in the study were born in the Perinatal Centre of the Hospital Centre of University of Heidelberg (Perinatalzentrum der Universitäts-Frauenklinik, Universitätsklinikum Heidelberg) and/or provided intensive care treatment at the Neonatal Intensive Care Unit of the Perinatal Centre (Intensivstation für Frühgeborenen und kranke Neugeborene in der Frauenklinik - FIPS).

Concerning sex distribution there were 13 girls and 17 boys in the sample. Eighteen infants came out of single pregnancies and twelve infants came out of multiple pregnancies. There were 4 multiple pregnancies – one pair of twins, one infant out of another twin pregnancy and three times triplets. Therefore the number of parents' pairs was less than 30 i.e. there were 23 pairs of parents. Two of the mothers were single parents, whereby one of them had another child to take care of and the other got twins. Therefore there were 23 mothers and 21 fathers present in the baby's life at the moment of study enabling 28 infants to start growing up in an intact family with both parents.

The gestational age of premature born infants was from 27+0 gestational weeks i.e. 189 gestational days to 36+1 gestational weeks i.e. 253 gestational days at birth, with the mean value of 219,10 +/- 16,77 gestational days i.e. 31+2 gestational weeks. Three of them were extreme immature i.e. of gestational age less than 28 weeks (196 days). The birth weight of the sample premature born infants was from 470g to 2200g, with the mean value of 1421,50g +/-427,56g. Four of them were very low birth weight (less than 1000g) preterm infants. Twenty-three infants were appropriate-for-(gestational)-age (77%) and seven infants were small-for-(gestational)-date (23%).

The study was performed at the time when intensive care treatment was already over and premature infants were situated at the so called “intermediate intensive care unit” (Station H9 and Station H10). The suitable time for the study beginning was concerned the time when the infants were cardiorespiratory stable i.e. had neither apnoea nor bradycardia, which was on average 4 weeks after birth. At that point of time the corrected gestational age was from 30+3 gestational weeks (213 gestational days) to 41+4 gestational weeks (291 gestational days), with the mean value of 249,77 +/- 13,2 i.e. 35+5 gestational weeks. The actual weight at the time of study performance was from 1260g to 2620g, with the mean value of 2038,67 +/- 298,98g.

Social-demographic data of the sample show that the mother’s age at the moment of child’s birth was from 17 to 41 years, with the 33,57 as the mean value (+/-5,67), whereby father’s age at the moment of child’s birth was from 17 to 50 with the 33,92 as the mean value (+/- 6,75). The level of parents’ education was on average the middle one, whereby there were more high-educated fathers than the high educated mothers. However 12 parents did not gave data about education level.

Concerning parturition, at the mentioned mothers’ average age of 33,57 years, the newborn infant was either the first or the second born child (1,7) to his mother, i.e. 17 out of 23 (74%) mothers were giving the birth to their first child. None of the mothers had more than four children (the newborn infant inclusive) i.e. none of the families had more than five family members.

Successfulness of pregnancies was as follows: 16 mothers out of 23 (70%) had no problems to get pregnant and carry out the pregnancy, whereby 6 mothers had already had one or more miscarriages and one of them had premature birth in the previous history. Artificial reproduction methods (reproductive medicine procedures) preceded four pregnancies. The actual (first) pregnancy was induced by the hormonal therapy in one mother and the *in vitro* fertilisation (IVF) was performed in further three mothers. Two of these three mothers underwent artificial fertilisation also in the previous history, one of them was successful and resulted in the already mentioned premature birth.

Concerning mothers’ health, all of the 23 mothers had some acute disease or medical problem that appeared in actual pregnancy and could have acted as possible reason for premature delivery (the immediate reason for a premature birth). Mothers’ health states in the pregnancy are given in the Table below. The chronic disease or medical problem appeared in 13 mothers, 7 mothers did not mention any health problems at all, and the data about health state of 3 mothers were missing. Chronic diseases of the mothers are given in the same Table (please see below):

Table 9.1. Mothers‘ health state in the pregnancy and chronic diseases of the mothers

Mother’s health state:	Number	Chronic diseases of the mothers	Number
Drohende Frühgeburt/ vorzeitige Wehen	11	Depression	1
Vaginale Blutung	3	Z.n. IVF	2
Retrochoriales Hämatom	1	Gemini nach Hormontherapie	1
vorzeitige Plazentalösung	1	Z.n. Thrombosis v. jugularis, v. subclavia, v. axillaries	1
vorzeitiger Blasensprung PROM	3	Tromboseneigung in der Familie (bei Großmutter)	1
Cerclage	2	Lungenembolie	1
V.a.Infekt	5	Chronische Hepatitis C	1
CRP Erhöhung	5	Leberteilresektion mit rez. Lebercysten	1
Leukocytose	2	Z.n. Pancreatitis	1
Harnweginfektsinfektion	2	Neurodermitis	1
Akute CMV Infektion	1	Psoriasis	1
Plazentainsuffizienz	4	Bandscheibevorfall	1
Oligohydramnion	3	Hüftdysplasie	2
IUGR	4	Doppelniere bds.	2
EPH-Gestose	3	keine Angabe	3
HELLP Syndrom	3	Keine	7
Anämie	1		
Beinvenen thrombose	1		
Nikotin-Abusus	3		
Insulinpflichtiger Gestationsdiabetes	1		
Z.n. ICSI (intrazytoplasmatische Spermatozoeninjektion)	2		
Z.n. Konisation & Abrasio	1		

The premature infants' health states at birth and during the hospital stay at the Neonatology Department are given in the following Table:

Table 9.2.: The premature infants' health state at birth and during the hospital stay at the Neonatology Department (Group of diseases, diagnosis and number of infants)

Outcome of the delivery (Z37)	Single live birth (Z37.0)	18
	Twins, both liveborn (Z37.2)	3
	Triplets, all three liveborn (Z37.5)	9
Disorders related to length of gestation and foetal growth (P05-P08)	Extreme immaturity (less than 28 completed weeks /196 completed days of gestation (P07.2)	3
	Other premature infants (28 completed weeks or more but less than 37 completed weeks of gestation) (P07.3)	27
	Light for gestational age, Small for gestational age, Small-and-light-for gestational age, Slow foetal growth (foetal growth retardation) (P05)	7
Respiratory and cardiovascular disorders specific to the perinatal period (P20-P29) and other respiratory disorders	Other apnoea of newborn (Apnoea-bradycardia-syndrome) (P28.4)	20
	Other specified respiratory conditions of newborn (Disorder of cardiorespiratory adaptation) (P28.8)	19
	Respiratory distress syndrome of newborn (P22.0)	9
	Bronchopulmonary dysplasia originating in the perinatal period (P27.1)	5
	Transient tachypnoea of newborn (P22.1)	2
	Interstitial emphysema originating in perinatal period (P25.0)	2
	Pneumothorax originating in perinatal period (P25.1)	1
	Intrauterine hypoxia, unspecified (P20.9)	1
	Respiratory failure of newborn (P28.5)	1
	Respiratory failure, unspecified (J96.9)	1
	Respiratory condition of newborn, unspecified (P28.9)	1
	Persistent foetal circulation (P29.3)	6
	Respiratory arrest (R09.2)	1
Infections specific to the perinatal period (P35-P39) and other infections	Sepsis of newborn due to Staphylococcus aureus (P36.2)	1
	Other bacterial sepsis of newborn (P36.8)	2
	Other specified (bacterial) infections specific to the perinatal period (P39.8)	3
	Foetus and newborn affected by maternal infectious and parasitic diseases (Hepatitis B/C positive mother, newborn affected by maternal disease, but not itself manifesting that disease) (P00.2)	3
	Acute conjunctivitis, unspecified (H10.3)	8
	Viral conjunctivitis, unspecified (B30.9)	1
	Acute upper respiratory infection, unspecified (J06.9)	1
Haemorrhagic and haematological disorders of foetus and newborn (P50-P61)	Intraventricular (nontraumatic) haemorrhage, grade 1, of foetus and newborn (P52.0)	2
	Neonatal cutaneous haemorrhage (P54.5)	1
	Neonatal jaundice associated with preterm delivery (P59.0)	8
	Anaemia of prematurity (P61.2)	8
	Transient neonatal thrombocytopenia (P61.0)	1

Continuation of the Table 9.2.: The premature infants' health state at birth and during the hospital stay at the Neonatology Department (Group of diseases, diagnosis and number of infants)

Diseases of the circulatory system (I00-I99)	Supraventricular tachycardia (I47.1) in observation, not confirmed	1
	Other und unspecified premature depolarization (I49.4)	1
	Other hypotension (I95.8)	10
Congenital malformations, deformations and chromosomal abnormalities (Q00-Q99)	Atrial septal defect (Q21.1)	6
	Ventricular septal defect (Q21.0)	1
	Stenosis of pulmonary artery (Q25.6)	1
	Other congenital malformations of aorta (Q25.4)	1
	Microcephaly (Q02)	1
	Accessory kidney (Q63.0) in observation	1
	Metatarsus varus (Q66.2)	1
	Congenital neoplastic naevus (Q82.5)	1
	Bilateral inguinal hernia, without obstruction or gangrene (K40.2)	2
	Unilateral inguinal hernia, without obstruction or gangrene (K40.9)	4
	Hernia umbilicalis without obstruction or gangrene (K42.9)	1
	Encysted hydrocele (testis) (N43.0)	4
Disorders of choroid and retina (H30-H36)	Retinopathy of prematurity (H35.1)	4
Benign neoplasms (D10-D36)	Haemangioma, any site (D18.0)	4
Other disorders originating in the perinatal period (P90-P96)	Slow feeding of newborn (P92.2)	28
Transitory endocrine and metabolic disorders specific to foetus and newborn (P70-P74)	Syndrome of infant of mother with gestational diabetes (P70.0)	1
	Other neonatal hypoglycaemia (P70.4)	3
	Other neonatal hypocalcaemia (P71.1)	3
	Late metabolic acidosis (P74.0)	2
	Disturbances of sodium balance of newborn (P74.2)	1
	Other transitory electrolyte disturbances of newborn (P74.4)	1

Received medical treatment is given in Table 9.3.:

Table 9.3.: The medical treatment the premature infants' received at birth and during the hospital stay at the Neonatology Department

Respiratory system treatment	**Oxygen**	**24**
	Mask-ventilation	20
	CPAP	20
	CPAP only	13
	Intubation & Mechanical ventilation	9
	Primary intubation	2
	Secondary intubation (after CPAP)	7
	Re-Intubation & Repeated mechanical ventilation	1
	Surfactant	8
	Reanimation	1
	Katecholamine	1
	Hydrocortison	5
	Inhalation (Pulmicort, Micronephrin)	4
	Coffein/Coffeincitrat	16
	Diuretics	2
	Pleural drainage	1
Retinopathy treatment	Oxygen	2
Circulation support	Biseko (Albumine & Immunoglobuline)	11
	Fresh-Frozen-plasma	1
	Indometacin	6
Antibiotics	Ampicillin	4
	Ampicillin + Gentamycin	17
	Monomycin (Erythromycin)	1
	Claforan (Cefotaxim)	2
	Claforan + Ampicillin	3
	Claforan + Monomycin	1
	Zinacef (Cefuroxime)	3
	Ecolicin eye ointment (Erythromycin + Colistin)	7
Jaundice treatment	Phototherapy	10
Anaemia treatment	NeoRecormon (Erythropoetin)	10
	Erythrocytes concentrate or full blood transfusion	5
	Ferro-Sanol (peroral iron substitution)	4
Feeding	Partly parenteral nutrition	22
	Partly probe nutrition	17
Substitution therapy	Na-bicarbonat	6
	Na-glycerophosphat	8
	Ca-gluconat	6
	Ca/P substitution	6
	Vitamin D3	11

9.2. Results of hearing test ability

At 28 from 30 children the hearing ability test (otoacoustic emissions (OAE) test) was normal. The otoacoustic emissions (OAEs) produced in the cochlea as an answer on a wide range frequency clicks (probe in the outer ear) and reflected back through the middle ear into the outer auditory canal were detected.

By the rest two children the otoacoustic emissions could not be registered at the time of study performance. Their recordings were not included in statistical analysis.

9.3. Heart rate variability measures and their cods used for statistical analyses

As previously said (please see Chapter 8.6), the observed heart rate variability measures were the following eight:

1) NN interval mean value (ms) (MI);
2) NN intervals median (ms) (ME);
3) variance of NN interval length (VA);
4) standard deviation of NN interval length (SA);
5) pnn 6,25 (%) – the number and the proportion of interval differences of successive NN intervals greater than 6,25 ms i.e. number of adjacent NN interval pairs that deviate more than 6,25 ms from each other (P6);
6) RMSSD – square root of the square mean values of all the differences between two adjacent / successive NN intervals (RM);
7) SDSD – standard deviation of the differences between adjacent / successive NN intervals (SD); and
8) RSA – respiratory sinus arrythmia - the mean of the differences between two consecutive extreme values (HPD maximum and HPD minimum) i.e. mean value of differences between the lowest and the highest successive value of the NN interval (RS).

These heart rate variability measures data were managed, calculated, analysed and evaluated for each time section separately i.e. *before*, *during* and *after* each particular acoustic stimulation, for the control (C) situation, lullaby (L) acoustic stimulation and fairytale (M) acoustic stimulation as well as separately for the non-REM sleep, REM sleep, sleep *in toto*, awake states and total recording. The variable cod used for statistical analyses can be seen here, whereby the complete list of all 360 variable cods is given in the Appendix (Appendix 9.1.):

VARIABLE COD USED FOR STATISTICAL ANALYSES:

First letter for the acoustic stimulation: C, L or M:

C – control situation without any acoustic stimulation, "placebo acoustic stimulation"
L – lullaby music as acoustic stimulation
M – fairytale reading as acoustic stimulation

Second letter for the time section: B, D and A:

B – before, 15 minutes before acoustic stimulation started
D – during, 15 minutes during the acoustic stimulation or placebo acoustic stimulation (C)
A – after, 15 minutes after the acoustic stimulation

Third letter for the behavioural state: N, R, W, S and T:

N – non-REM sleep
R – REM sleep
S – total sleep
W – awake
T – total recording

Fourth and fifth letter for the heart rate variability measure:

MI – NN interval mean value
ME – NN interval median
VA – variance
SA – standard deviation
P6 – pnn 6,25
RM – RMSSD
SD – SDSD
RS – RSA

The preliminary statistical analyses, i.e. assessing normality of the heart rate variability measures were performed on all 360 variables.

Further statistical analyses of heart rate variability, however, were performed for the non-REM sleep time sections variables only (72 variables). Since non-REM sleep states are physiologically characterised by the most regular respiration and most regular heart rate, the analysis of non-REM sleep time sections only enables to reach the baseline as regular as possible, and, therefore, be in the situation to catch the slightest differences under influence of an acoustic stimulation.

The variable cods for the 72 variables concerning non-REM sleep time sections can be seen in the following Table:

Table 9.4: Variable cods used for the non-REM sleep time sections statistical analyses.

	C (n=19)			**L (n=29)**			**M (n=30)**		
	B	**D**	**A**	**B**	**D**	**A**	**B**	**D**	**A**
MI	CBNMI	CDNMI	CANMI	LBNMI	LDNMI	LANMI	MBNMI	MDNMI	MANMI
ME	CBNME	CDNME	CANME	LBNME	LDNME	LANME	MBNME	MDNME	MANME
VA	CBNVA	CDNVA	CANVA	LBNVA	LDNVA	LANVA	MBNVA	MDNVA	MANVA
SA	CBNSA	CDNSA	CANSA	LBNSA	LDNSA	LANSA	MBNSA	MDNSA	MANSA
P6	CBNP6	CDNP6	CANP6	LBNP6	LDNP6	LANP6	MBNP6	MDNP6	MANP6
RM	CBNRM	CDNRM	CANRM	LBNRM	LDNRM	LANRM	MBNRM	MDNRM	MANRM
SD	CBNSD	CDNSD	CANSD	LBNSD	LDNSD	LANSD	MBNSD	MDNSD	MANSD
RS	CBNRS	CDNRS	CANRS	LBNRS	LDNRS	LANRS	MBNRS	MDNRS	MANRS

According to the recent research and mentioned recommendations for measurement and analysis in paediatric sleep laboratory (Patzak et al. 2002; Aikele 1997; Lipke 1997), it was shown that for the appropriate analysis of heart rate variability in young infants (age of 0-6 months) it could be enough to analyse periods of recordings of only two minutes length.

According to these *state of art* recommendations and assuming that the selected periods of two minutes duration could be enough also for the appropriate analysis of the heart rate variability in premature infants, the statistical analyses were performed for the two minutes non-REM sleep periods, cut out the whole recordings. The non-REM sleep periods of two minutes duration were cut out from the respective (before, during, after) non-REM sleep data sections randomly by the means of "Excel's random generator".

The corresponding cods for the 72 variables concerning two minutes non-REM sleep time sections are presented in the following Table:

Table 9.5: The cods for the 72 variables concerning two minutes non-REM sleep time sections

	C			L			M		
	B	**D**	**A**	**B**	**D**	**A**	**B**	**D**	**A**
MI	CBN2MI	CDN2MI	CAN2MI	LBN2MI	LDN2MI	LAN2MI	MBN2MI	MDN2MI	MAN2MI
ME	CBN2ME	CDN2ME	CAN2ME	LBN2ME	LDN2ME	LAN2ME	MBN2ME	MDN2ME	MAN2ME
VA	CBN2VA	CDN2VA	CAN2VA	LBN2VA	LDN2VA	LAN2VA	MBN2VA	MDN2VA	MAN2VA
SA	CBN2SA	CDN2SA	CAN2SA	LBN2SA	LDN2SA	LAN2SA	MBN2SA	MDN2SA	MAN2SA
P6	CBN2P6	CDN2P6	CAN2P6	LBN2P6	LDN2P6	LAN2P6	MBN2P6	MDN2P6	MAN2P6
RM	CBN2RM	CDN2RM	CAN2RM	LBN2RM	LDN2RM	LAN2RM	MBN2RM	MDN2RM	MAN2RM
SD	CBN2SD	CDN2SD	CAN2SD	LBN2SD	LDN2SD	LAN2SD	MBN2SD	MDN2SD	MAN2SD
RS	CBN2RS	CDN2RS	CAN2RS	LBN2RS	LDN2RS	LAN2RS	MBN2RS	MDN2RS	MAN2RS

9.4. Results of heart rate and heart rate variability - Results of heart rate and heart rate variability in two minutes data sections of non-REM sleep

Results of the preliminary statistical analysis:

<u>Assessing data normality:</u>

All of 360 heart rate variability measures variables were assessed for the normality of the distribution using the Kolmogorow-Smirnov test of Normality (for small samples). Almost all data show normal distribution i.e. 334 out of 360 variables. However, violation of the assumption of normality was registered for the 26 following variables: CBSP6, CASP6, CTSP6; LBNP6, LBNSD, LBSSD; LDRSD, LDNVA; MBRP6, MBRSD, MBNVA, MBNP6,

MBNSD, MBSP6, MBSSD; MDRP6, MDNP6, MDSVA, MDSP6; MARP6, MARSD, MANP6, MASP6, MTRP6, MTNP6, MTSP6.

<u>Descriptive statistics:</u>

Further, descriptive statistic analyses and Boxplot diagrams were used to describe and explore the data.

The results of the descriptive statistic analyses (NN interval mean value and standard deviation) for all HRV variables in two minutes data sections of non-REM sleep states *before*, *during* and *after* each intervention are displayed in the following Table:

Table 9.6: Descriptive statistics for all HRV variables in two minutes data sections of non-REM sleep states: NN interval mean value and standard deviation (NN interval mean value +/- standard deviation)

	C (n=20)			**L (n=29)**			**M (n=30)**		
	B	**D**	**A**	**B**	**D**	**A**	**B**	**D**	**A**
2MI	416,42 +/- 21,96	414,44 +/- 21,32	408,01 +/- 26,55	405,96 +/- 34,58	409,21 +/- 28,15	405,45 +/- 30,57	413,05 +/- 29,91	414,91 +/- 32,16	415,26 +/- 28,06
2ME	415,45 +/- 21,63	413,20 +/- 21,59	407,85 +/- 28,52	404,59 +/- 34,18	407,10 +/- 28,75	404,17 +/- 28,79	411,47 +/- 29,37	414,00 +/- 32,78	413,67 +/- 28,62
2VA	239,28 +/- 196,32	312,23 +/- 428,40	380,76 +/- 379,73	326,06 +/- 578,89	472,97 +/- 596,34	306,31 +/- 317,26	270,37 +/- 235,53	279,99 +/- 407,40	386,21 +/- 527,75
2SA	13,97 +/- 6,82	14,92 +/- 10,17	17,40 +/- 9,06	14,57 +/- 10,85	18,35 +/- 11,88	15,71 +/- 7,85	15,03 +/- 7,04	14,26 +/- 8,90	16,87 +/- 10,25
2P6	1,49 +/-3,20	0,90 +/- 1,73	1,08 +/- 2,08	2,74 +/- 5,59	4,15 +/- 6,11	2,56 +/- 4,49	2,67 +/- 5,92	2,66 +/- 6,30	3,79 +/- 10,64
2RM	5,17 +/- 3,12	5,12 +/- 2,92	5,20 +/- 2,75	6,14 +/- 4,42	7,14 +/- 4,20	6,03 +/- 3,31	6,30 +/- 4,64	6,07 +/- 4,38	6,75 +/- 6,32
2SD	4,62 +/- 2,30	5,93 +/- 5,39	5,19 +/- 2,63	5,74 +/- 4,23	7,50 +/- 5,51	6,07 +/- 3,46	6,62 +/- 6,51	5,30 +/- 4,12	7,37 +/- 8,67
2RS	4,30 +/- 2,67	5,51 +/-5,24	6,08 +/- 4,45	4,78 +/- 4,31	6,04 +/- 5,13	4,84 +/- 3,22	4,74 +/- 3,21	5,13 +/- 5,16	6,08 +/- 8,21

Boxplot diagrams presenting changes of the HRV variables in two minutes data sections of non-REM sleep states *before*, *during* and *after* each intervention are given in the Appendix (Appendix 9.2.).

Analysis of the variance:

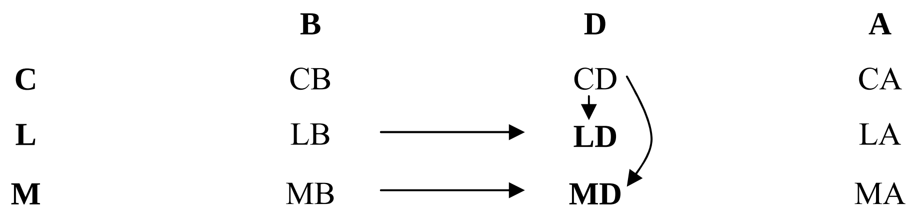
In order to explore differences and find out if there is a statistically significant difference among different acoustic intervention procedures (L and M) versus no acoustic stimulation (C) the analysis of variance was performed.

For the analysis of variance the parametric test ANOVA was used. Since the same infants' HRV variables were measured on more than two occasions, the ANOVA variant *repeated-measures-ANOVA* was conducted.

The influence of one categorical variable - factor "acoustic stimulation" (C, L, M) and the influence of another categorical variable - factor "time" (before, during, after) as well as the influence of their interaction – interaction between acoustic stimulation and time (n=19) on each of the eight continuous dependent HRV variables (NN interval mean value, NN interval median, variance, SD, pnn 6,25, RMSSD, SDSD and RSA) was explored. This was tested by a series of 2x3 (factor x level) *two-way repeated-measures ANOVAs* for each HRV variable separately. For the found statistically significant differences and in order to locate them *T*-tests were performed as post-hoc tests.

The following schema (Schema 9.1.) presents the expectations. Concerning influence of acoustic stimulation in the course of time, the greatest differences are expected to be registered for the factor acoustic stimulation between LD & CD, MD & CD and possibly MD & LD for the time section during, as well as for the factor time between LB & LD, MB & MD and possibly MD & LD:

Schema 9.1: Expectations of the greatest statistical differences between interventions in the course of time



These analyses of variance (two-way repeated measures ANOVAs) revealed statistically significance difference for the following variables:

1) NN interval **mean value** for the factor “acoustic stimulation” (Wilk’s-Lambda=0,587; F[2,17]=5,992; eta^2=0,413; p=0,011) and for the factor “time” (Wilk’s-Lambda=0,574; F[2,17]=6,300; eta^2=0,426; p=0,009); The post-hoc tests have shown that statistically significant difference exists between NN interval mean value in control and fairytale situation for the time section *during* CD2 & MD2 (p=0,042) as well as for the time section *after* CA2 & MA2 (p=0,016), showing that *NN interval mean value rises during and after fairytale* acoustic stimulation; and

2) NN interval **median** for the factor “acoustic stimulation” (Wilk’s-Lambda=0,605; F[2,17]=5,549; eta^2=0,395; p=0,014) as well as for the factor “time” (Wilk’s-Lambda=0,677; F[2,17]=4,051; eta^2=0,323; p=0,036). The post-hoc tests have shown that statistically significant difference exists between NN interval median in control and fairytale situation for the time section *after* i.e. between CA2 & MA2 (p=0,040), showing that NN interval *median rises after fairytale* acoustic stimulation.

In order to explore the influence of one categorical variable - factor “acoustic stimulation” in the same time section (before, during, after) (n=19) on each of the eight continuous dependent HRV measures variables, a series of 1x3 (factor x level) *one-way repeated measures ANOVAs* for all eight HRV variables were conducted. These analyses of variance revealed following statistically significant differences:

For the time section *before* the one-way analysis of variance revealed no statistically significant differences between three acoustic situations - the control (C) situation, lullaby (L) acoustic stimulation and fairytale (M) acoustic stimulation, i.e. there was no difference in the starting (initial) situation for the data of all eight heart rate variability variables.

For the time section *during* the one-way analysis of variance revealed statistically significant difference for the following variables:

1) **pnn 6,25** (Wilk’s-Lambda=0,686; F[2,17]=3,892; eta^2=0,314; p=0,041), post-hoc tests showing statistically significant difference between CD2 & LD2 situation, *pnn 6.25 rises during lullaby* acoustic stimulation (p=0,010); and

2) **RMSSD** (Wilk’s-Lambda=0,683; F[2,17]=3,948; eta^2=0,317; p=0,039), post-hoc tests showing statistically significant difference also between CD2 & LD2 acoustic stimulation, *RMMSD rises during lullaby* acoustic stimulation (p=0,010).

For the time section *after* the one-way analysis of variance revealed statistically significant difference for the following variables:

1) NN interval **mean value** (Wilk's-Lambda=0,612; F[2,17]=5,380; eta^2=0,388; p=0,015); Post-hoc tests showed statistically significant difference between CA2 & MA2, NN interval *mean value rises after fairytale* acoustic stimulation (p=0,016); and
2) NN interval **median** (Wilk's-Lambda=0,664; F[2,17]=4,303; eta^2=0,336; p=0,031); Post-hoc tests showed statistically significant difference between CA2 & MA2, NN interval *median rises after fairytale* acoustic stimulation (p=0,040).

However, there was no significant difference between influence of C, L and M acoustic stimulation on other HRV variables – variance, standard deviation, SDSD and RSA.

Analyses of variance 1x3 (factor x level) repeated measures ANOVA exploring the effect of acoustic stimulation lullaby (L) vs. acoustic stimulation fairytale (M) (n=29) revealed statistically significant difference for the following variables:

1) **variance** for the interaction between the factor "acoustic stimulation" and factor "time" (Wilk's-Lambda=0,764; F[2,27]=4,166; eta^2=0,236; p=0,026); Post-hoc tests have revealed that statistically significant difference exists between LD2 & MD2 (p=0,022), showing that *variance rises during lullaby* acoustic stimulation;
2) **standard deviation** for the interaction between the factor "acoustic stimulation" and factor "time" (Wilk's-Lambda=0,767; F[2,27]=4,101; eta^2=0,233; p=0,028); Post-hoc tests have revealed that statistically significant difference exists between LD2 & MD2 (p=0,022), showing that *standard deviation rises during lullaby* acoustic stimulation; and
3) **SDSD** also for the interaction between the factor "acoustic stimulation" and factor "time" (Wilk's-Lambda=0,749; F[2,27]=4,531; eta^2=0,251; p=0,020); Post-hoc tests have revealed that statistically significant difference exists between LD2 & MD2 (p=0,033), showing that *SDSD rises during lullaby* acoustic stimulation.

By the one-way repeated measures ANOVA conducted without control situation on the same sample (L. vs. M; n=19) it was also shown that NN interval mean value rise after mother's voice and NN interval median rise both during and after mother's voice.

However, by the one-way repeated measures ANOVA (L vs. M; n=29) it was shown that NN interval variance, NN interval standard deviation and SDSD rise during lullaby music.

The complete results of the above mentioned analyses of variance are displayed in the Appendix as SPSS-output data (Appendix 9.3.).

Effect size (Cohen 1988; Pallant 2005) for all statistically significant differences was large.

9.5. Results of parental questionnaires - parental stress, parental competence and functionality of the family

Parental stress was assessed by Parental current stress assessment scale (Vonderlin 1999) exploring stress by the means of two scales: the scale "Burden" ("Belastung") and the scale "Resources" ("Ressourcen") (please see Chapter 6). These stress questionnaires were filled in by 23 mothers of 28 infants and by 19 fathers of 23/24 infants. The registered scores of parental "Burden" and "Resources" are given in Table 9.7. and Table 9.8.:

Table 9.7.: Parental current stress assessment scale, parental "Burden", scale range from 9 to 36, higher scores speaking for higher burden

Burden	**Mothers (n=28)**	**Fathers (n=24)**	**Parents (n=24pairs)**
Minimum	10	14	13
Maximum	23	27	25
Mean value +/- standard deviation	15,64 +/- 3,16	19,25 +/- 3,08	17,54 +/- 2,73

The mean parental burden and parental resources scores on the parental stress scale were in the "normal" scale range between quartile 25% and quartile 75% (Vonderlin 1999).

The mean parental burden score was 17,54 (quartile 25%=15 for both mothers and fathers, quartile 75%=23 for mothers and 20 for fathers), the mean maternal burden was 15,64 and the mean paternal burden was 19,25, all three values between quartile 25% and quartile 75%. Minimum values for parental burden were lying at 13 and maximum values at 25, although minimum values for the mothers lie at 10 and for the fathers at 14 and maximum values for mothers lie at 23 and for fathers at 27.

The mean parental burden (17,54 at the scale range 9-36) was about a median (median 50%=18, for both mothers and fathers), whereby the mean maternal burden (score 15,64 at the scale range 9-36) was found to be something bellow the median and the mean paternal burden (score 19,25 at the scale range 9-36) was found to be something above the median.

Table 9.8.: Parental current stress assessment scale, parental "Resources", scale range from 6 to 24, higher scores speaking for higher resources

Resources	**Mothers (n=28)**	**Fathers (n=23)**	**Parents (n=23pairs)**
Minimum	15	14	16
Maximum	24	24	24
Mean value +/- standard deviation	21,46 +/- 2,60	21,57 +/-2,29	21,85 +/-1,74

The mean parental resources scores were 21,85 (quartile 25%=20 for mothers and 19 for fathers, quartile 75%=23 both for mothers and fathers), the mean maternal resources were 21,46 and the mean paternal resources were 21,57, all three values between quartile 25% and quartile 75%. Minimum values for parental resources were lying at 16 and maximum values at 24; similarly, minimum values for the mothers lie at 15 and for the fathers at 14 and maximum values both for mothers and fathers lie at 24.

The mean parental resources were about a median (median 50%=22 for mothers and 21 for fathers), both for mothers (score 21,46 at the scale range 6-24) and fathers (score 21,57 at the scale range 6-24).

Parental competence was assessed by Parental competence assessment scale (Schneewind 1989) (please see Chapter 6). These questionnaires were filled in by 23 mothers of 28 infants and by 19 fathers of 19 infants. The registered scores of parental competence are given in Table 9.9:

Table 9.9: Parental competence scale, scale range from 8 to 48, lower scores (8-24) speaking for higher competence

Competences	**Mothers (n=28)**	**Fathers (n=19)**	**Parents (n=19pairs)**
Minimum	8	8	8

Maximum	35	24	27
Mean value +/- standard deviation	16,98 +/- 6,69	16,11 +/- 4,97	17,04 +/- 4,97

The mean parental competence scores on the parental competence scale (16,98) was rated high (at the scale range 8-48, lower scores (8-24) speaking for higher competence, Schneewind 1989).

The mean parental competence scores was 17,04, the mean maternal competence was 16,98 and the mean paternal competence was 16,11, all three values speaking for higher competence (scale range 8-24).

Maximum competence values for parental competence were lying at 8 both for mothers and fathers. Minimum competence values for parental competence were lying at 27, whereby at 24 for fathers and even lower for mothers at 35.

Family functionality was measured by Family Assessment Measure (Cierpka 1994) (please see Chapter 6) by the means of the following 9 scales: task accomplishment, role performance, communication, emotionality, affective involvement, control, values & norms, social desirability, defence. The scores of each scale as well as the whole family functionality score is given in the following Table:

Table 9.10: Family functionality scales - task accomplishment scale, role performance scale, communication scale, emotionality scale, affective involvement scale, control scale, values & norms scale, social desirability scale and defence scale; Scale ranges from 40 to 60 are considered as normal - higher scores than 60 speaking for family problems, lower scores than 50 for family strengths, lower scores than 40 though for lower validity of scale due to other influences (for example, projections):

Task accomplishment scale (AE)	**Mothers (n=26)**	**Fathers (n=25)**
Minimum	37	38
Maximum	73	76
Mean value +/- standard deviation	46,08 +/- 10,28	50,92 +/- 11,12

Role performance scale (RV)	**Mothers (n=23)**	**Fathers (n=25)**

Minimum	35	38
Maximum	56	64
Mean value +/- standard deviation	44,04 +/- 5,76	44,84 +/- 7,16

Communication scale (KOM)	**Mothers (n=26)**	**Fathers (n=24)**
Minimum	38	37
Maximum	89	71
Mean value +/- standard deviation	51,19 +/- 13,81	46,21 +/- 9,75

Emotionality scale (E)	**Mothers (n=23)**	**Fathers (n=25)**
Minimum	37	37
Maximum	64	64
Mean value +/- standard deviation	49,43 +/- 7,35	48,20 +/- 6,98

Affective involvement scale (AB)	**Mothers (n=26)**	**Fathers (n=25)**
Minimum	36	39
Maximum	71	76
Mean value +/- standard deviation	42,35 +/- 9,29	48,24 +/- 8,95

Control scale (K)	**Mothers (n=22)**	**Fathers (n=22)**
Minimum	33	35
Maximum	69	68
Mean value +/- standard deviation	47,45 +/- 9,38	48,45 +/- 9,23

Values & Norms scale (WN)	**Mothers (n=26)**	**Fathers (n=25)**
Minimum	35	35
Maximum	68	69
Mean value +/- standard deviation	46,62 +/- 8,12	48,28 +/- 7,50

Social desirability scale (SE)	**Mothers (n=23)**	**Fathers (n=21)**
Minimum	40	36
Maximum	75	72
Mean value +/- standard deviation	54,05 +/- 8,46	57,05 +/- 10,13

Defence scale (A)	Mothers (n=26)	Fathers (n=25)
Minimum	46	37
Maximum	82	75
Mean value +/- standard deviation	57,42 +/- 10,01	53,44 +/- 8,78

Family functionality scales Sum	Mothers (n=23)	Fathers (n=21)
Minimum	30	34
Maximum	74	72
Mean value +/- standard deviation	45,48 +/- 10,94	47,86 +/- 8,29

It can be seen that the mean value of the score of each scale particularly as well as mean value of score of the family functionality sum is in the normal range from 40 to 60, although there are families with scores bellow 40 (low validity due other influences) and above 60 (family problems).

9.6. Correlations between heart rate variability measures and parental stress, parental competence and functionality of the family

In order to answer the third hypothesis (see Chapter 7.2.), the Pearson correlations between HRV measures (NN interval mean value, NN interval median, variance, standard deviation, pnn 6.25, RMSSD, SDSD and RSA), on one side, and scores on scales concerning mothers' well-being (maternal stress with subscales burden sum and resources sum; maternal competence sum; sum of the family functionality scale, and its subscales: task accomplishment, role performance, communication, emotionality, affective involvement, control, values and norms, social desirability, defence), on the other side, were performed.

The Pearson correlations results are given in the Appendix as SPSS-output data (Appendix 9.4.).

According to Cohen (Cohen 1988), the correlations were considered large when r=0.50 to 1.00 or r=-0.50 to -1.00, moderate when r=0.30 to 0.49 or r=-0.30 to -0.49 and small when r=0,10 to 0,29 or –0,10 to –0,29. The large correlations between HRV measures during and after fairytale and scales concerning mothers' well-being are given in the in the following table (Table 9.11). Since in a small sample (n=30), one can have moderate correlation that do not reach statistical significance at the traditional p<0,05 level, also moderate correlations are given:

Table 9.11: Correlations between HRV measures *during* and *after* fairytale acoustic stimulation, on one side, and scores on scales concerning mothers' well-being, on the other side. Large and moderate correlations (r ≥ ± 0,30) are given.

Correlations	**MDN2ME MAN2ME**	**MDN2MI MAN2MI**	**MDN2VA MAN2VA**	**MDN2SA MAN2SA**	**MDN2P6 MAN2P6**	**MDN2RM MAN2RM**	**MDN2SD MAN2SD**	**MDN2RS MAN2RS**
BELMSUM			+0,408* a	+0,392* a				+0,334a
RESMSUM	-0,324 d	-0,318 d					-0,320 d	
EKMSUM			+0,358 a	+0,355 a			+0,522** a	
SUMMT								
AEMT								
RVMT								
KOMMT								
EMT								
ABMT								
KMT	-0,357 d -0,325 a	-0,385 d -0,335 a			-0,340 a	-0,403 d -0,369 a	-0,388 d	
WNMT								
SEMT								
AMT	-0,329 d	-0,331 d						

d=during; a=after; * p<0,05, ** p<0,01; BELSUM = mothers' burden score, RESMSUM = mothers' resources score, EKMSUM = mothers' competence score, SUMMT = mothers' family functionality score, AEMT = mothers' task accomplishment score, RVMT = mothers' role performance score, KOMMT = mothers' communication score, EMT = mothers' emotionality score, ABMT = mothers' affective involvement score, KMT = mothers' control score, WNMT = mothers' values & norms score, SEMT = mothers' social desirability score, and AMT = mothers' defence score

Plenty of (small, moderate and large) correlations were found between HRV measures (NN interval mean value, NN interval median, variance, standard deviation, pnn 6.25, RMSSD, SDSD and RSA), on one side, and scores on scales concerning mothers' well-being (maternal stress with subscales burden sum and resources sum; maternal competence sum; sum of the family functionality scale, and its subscales: task accomplishment, role performance, communication, emotionality, affective involvement, control, values and norms, social desirability, defence), on the other side (Appendix 9.4.). These correlations were both positive and negative.

Taking into consideration only moderate and large correlations (Table 9.11.), there are positive correlations between Parental stress and heart rate variability measures, negative correlations between Parental competence and heart rate variability measures, and negative correlations between Family functionality and heart rate variability measures.

There is positive correlation between mothers' burden and heart rate variability measures, i.e. higher burden was associated with higher NN interval variance, standard deviation and RSA after fairytale acoustic stimulation.

There is negative correlation between mothers' resources and NN interval median, NN interval mean value and SDSD, i.e. lower scores on the scale resources are associated with higher NN interval median, NN interval mean value and SDSD during fairytale acoustic stimulation.

There is positive correlation between Parental competence scores and heart rate variability measures, i.e. less competence (higher score) is associated with higher variance, standard deviation and SDSD after fairytale acoustic stimulation.

There is negative correlation between Family functionality subscales scores and heart rate variability measures.

Lower scores on Control scale are associated higher NN interval median, NN interval mean value, RMSSD and SDSD, all during fairytale acoustic stimulation. Also lower scores on Control scale are associated with higher NN interval median, NN interval mean value, pnn 6.25 and RMSSD, all after fairytale acoustic stimulation

Lower score on Defence scale are associated with higher NN interval median and NN interval mean value during fairytale acoustic stimulation.

Chapter ten

Discussion of the study results

10.1. Summary of the study results

The effects of three acoustic stimulation situations (“Lullaby Music”, “Mother’s Voice” and “Control”) on heart rate variability of premature infants were assessed by analysis of eight heart rate variability measures: NN interval mean value, NN interval median, variance, standard deviation, pnn 6,25, RMSSD, SDSD and RSA. These eight heart rate variability measures were analysed *before*, *durin*g and *after* three acoustic stimulation situations, in the non-REM sleep sections of two minutes duration, which were randomly cut out from the respective (before, during, after acoustic stimulation) non-REM sleep data sections in the continuous electrocardiogram.

The analyses of variance, one-way and two-way repeated measures ANOVA, were performed on these eight heart rate variability (HRV) measures. The performance of different statistical procedures revealed statistically significant increase of different HRV measures during different acoustic stimulation interventions (see the following Table):

Table. 10.1.: HRV of preterm infants *before*, *during* and *after* acoustic stimulation

HRV measure	before	during	After
NN interval mean value		Mother’s voice [1]	Mother’s voice [1, 2, 3]
NN interval median		Mother’s voice [3]	Mother’s voice [1, 2, 3]
NN interval variance		Lullaby music [4]	
NN interval standard deviation		Lullaby music [4]	
pnn 6,25		Lullaby music [2]	
RMSSD		Lullaby music [2]	
SDSD		Lullaby music [4]	
RSA			

Note: Statistically significant (p<0,05) differences are given.
Statistical method used:
[1] – Two-way ANOVA repeated measures; C, L, M; n=19; factor “acoustic stimulation” and “time” and interaction between the acoustic stimulation and time
[2] – One-way ANOVA repeated measures; C, L, M; n=19; factor “acoustic stimulation”
[3] – One-way ANOVA repeated measures; L, M; n=19; factor “acoustic stimulation”
[4] – One-way ANOVA repeated measures; L, M; n=29; factor “acoustic stimulation”

However, the most appropriate analysis to test our hypotheses was the two-way repeated measures ANOVA analysis of variance. This analysis of variance (performed for "Lullaby Music", "Mother's Voice" and "Control"; "acoustic stimulation" and "time" as factors, testing also for the interaction between the acoustic stimulation and time; n=19) discovered the following statistically significant differences:

Before either of acoustic stimulation situations, there were no statistically significant differences between acoustic stimulation situations in any of investigated heart rate variability measures.

During acoustic stimulation situation, statistically significant differences were shown for NN interval mean value during fairytale acoustic intervention. Fairytale, i.e. mother's voice acoustic stimulation lead to a heart rate decrease, to an increase in NN interval mean value, and according to that, to an increase in the heart rate variability of premature infants.

After acoustic stimulation situation, statistically significant differences were shown for NN interval mean value and NN interval median, both after fairytale acoustic stimulation. Fairytale, i.e. mother's voice as acoustic stimulation lead to a heart rate decrease and an increase in two overall HRV measures - NN interval mean value and NN interval median, i.e. lead to an increase in heart rate variability of premature infants.

Statistically significant increased heart rate variability was, therefore, shown both during and after fairytale acoustic stimulation.

Further, the parental stress, parental competence and functionality of the family were assessed in order to test the possible influence of the mother's well-being on the calming quality of her voice and thereby on the premature infant's heart rate variability. This influence was formulated in the third hypothesis: "mother's voice from a mother who manages her current stress better, who feels in parent-child interactions more competent and who has a more functional family will bring the most of desired calming effect" (see Chapter 7).

The study results regarding the assessment of the parental stress, parental competence and functionality of the family revealed as follows (see also Table 10.2. on the next page):

The mean maternal burden on the Parental stress scale was reported to be middle, actually something below median, and the mean maternal resources on the Parental stress scale were also reported to be middle, actually also something below median.

The mean maternal competence on the Parental competence scale was rated high.

The mean value of the family functionality sum score on the Family Assessment Measure as well as each mean value of each family functionality scale on the Family Assessment Measure (task accomplishment scale, role performance scale, communication scale, emotionality scale, affective involvement scale, control scale, values & norms scale, social desirability scale and defence scale) were within the normal range, although there were families with scores below and above normal range.

Table 10. 2.: Mothers‘ well-being parameters

Well-being parameter (scale)	**Mothers (mean value ± SD)**	**Fathers (mean value ± SD)**
Burden (Range 9-36)	15,64 ± 3,16	19,25 ± 3,08
Resources (Range 6-24)	21,46 ± 2,60	21,57 ± 2,29
Competences	16,98 ± 6,69	16,11 ± 4,97
Family functionality (50±10)	45,48 ± 10,94	47,86 ± 8,29
Task accomplishment	46,08 ± 10,28	50,92 ± 11,12
Role performance	44,04 ± 5,76	44,84 ± 7,16
Communication	51,19 ± 13,81	46,21 ± 9,75
Emotionality	49,43 ± 7,35	48,20 ± 6,98
Affective involvement	42,35 ± 9,29	48,24 ± 8,95
Control	47,45 ± 9,38	48,45 ± 9,23
Values & Norms	46,62 ± 8,12	48,28 ± 7,50
Social desirability	54,05 ± 8,46	57,05 ± 10,13
Defence	57,42 ± 10,01	53,44 ± 8,78

Furthermore, the possible influence of the mother’s well-being on the calming quality of her voice and thereby on the premature infant’s heart rate variability was studied through the (Pearson) correlations between the parental stress’, parental competence’ and functionality of the family’ data given by the mothers/parents, on the one hand, and infants’ heart rate variability measures’ data, on the other hand.

Plenty of (small, moderate and large) correlations were found, suggesting a general association between mother’s well-being and infant’s heart rate variability (see Table 9.11.). These correlations were both positive and negative.

The (negative) correlations were registered between Control scale score, on the one hand, and NN interval mean value, NN interval median, RMSSD and SDSD, on the other hand, all during fairytale. The (negative) correlations were also registered between Control scale score and NN interval mean value, NN interval median, pnn 6,25, RMSSD, all after fairytale. The (negative) correlation was also found between Defence scale score, on the one hand, and NN interval mean value and NN interval median, on the other hand, both during fairytale. These correlations between the mothers' Control and Defence scale scores on the Family Assessment Measure and the premature infants' heart rate variability measures suggest that lower Control and Defence scale scores, i.e. higher functionality of the family is associated with a higher heart rate variability of preterm infants.

Against our expectations, the correlations found between maternal burden (positive correlations), maternal resources (negative correlations), maternal competence (positive correlations) and heart rate variability measures of preterm infants seem to suggest that higher burden (NN interval variance, standard deviation and RSA after fairytale) and lower resources of the mother (NN interval median, NN interval mean value and SDSD during fairytale), as well as lower competence of the mother (variance, standard deviation and SDSD after fairytale) were associated with a higher heart rate variability of premature born infants.

10.2. Discussion of the study results

10.2.1. Discussion of heart rate variability of preterm infants

The heart rate variability (HRV) investigation is a relatively new scientific and clinical approach.

The (lower) HRV was enlisted as indicator for an interaction between psyche and heart by depressive and/or adults under a lot of stress as health risk (for example, for a myocardial infarction / heart attack) (Carney et al. 2001; Hughes & Stoney 2000; Pehlivanidis et al. 2001; Sheffield et al. 1998). However, the implementation of low HRV was so far realised for only two clinical conditions (as risk predictor after a myocardial infarction and as early warning sign of a diabetic neuropathy).

Concerning the investigation of HRV in premature infants, this study enters also a relatively new ground.

The studies on heart rate variability showed very low specificity and sensitivity of HRV-measures, great inter-individual und intra-individual variability of HRV parameters (Patzak et al. 2002) as well as circadian rhythm variations (Massin et al. 2000). Since HRV represents a variable marker of autonomic activity of the heart, the HRV parameters modify with increasing age due to the maturation and progressive evolution of the autonomic nervous system and are also partially gender-related (Silvetti et al. 2001). In premature infants, HRV shows therefore a great complexity (Nakamura et al. 2005, Nakamura et al. 2006), an age dependency (Patzak et al. 2002, Nakamura et al. 2005) and, according to the latest studies, a gender dependency as well (Krueger et al. 2010a). Furthermore, besides all these phenomena, the HRV of preterm infants shows an environmental dependency: as the development of the brain itself, the maturation of the autonomic nervous system (and autonomic HR control) in preterm infants appears to be environmentally dependant and is, thus, affected by altered environment of the Neonatal Intensive Care Unit (NICU) vs. normal environment of womb, which could explain HRV being lower in preterm infants reaching their birth term than in full-term newborns at the time of birth (Eiselt et al. 2002).

First studies on heart rate variability in children started, therefore, with efforts to establish the standards for comparable performance and evaluation of paediatric polysomnography carried out in different laboratories (Wiater & Niewerth 2000), and were followed by the publishing of reference curves of polysomnographic parameters (inclusive instantaneous heart rate) for clinically healthy infants and children of an age range of 1 to 24 months (Schlüter et al. 2001), and further by recommendations for data-acquisition, pre-processing and analysis (Patzak et al. 2002).

HRV data as 10^{th}, 50^{th} and 90^{th} percentile in an age dependant manner were presented for children by Patzak et al. 2002. Normative values of HRV parameters for healthy newborn infants were given by Mehta et al. 2002 and by Longin et al. 2005. However, the reference values for HRV measures either in time- or frequency-domain for preterm infants have not yet been published.

The studies on heart rate variability in premature infants published so far mostly deal with sudden infant death syndrome (SIDS) and with the mechanisms of its origin, genesis and development (Nakamura et al. 2006; Hunt 2006). Thus, the interrelations between prone sleeping position (recognised as additional risk to prematurity for SIDS), heart rate variability (which seems to be reduced in prone sleeping position), and SIDS in prematurely born infants are of interest at the present time (Fifer et al. 2005; Ariagno et al. 2003; Goto et al. 1999; Constantin et al. 1999). Since the prevention of life-threatening events (ALTE) and SIDS requires deeper understanding of apnoea of prematurity and bradycardia, the efforts of current studies are to understand the development and the maturation of the respiratory system, the autonomous nervous system and, above all, the parasympathicus nervous system in preterm infants (Nakamura et al. 2006; Hunt 2006; Menke et al. 2003; Longin et al. 2006; Hata et al. 2005). Maturation of the autonomic nervous system with increasing age of preterm infant is accompanied by increasing HRV with a pronounced increase of parasympathetic activity. A normative trend, comprising the general increase in high-frequency components of HRV along with a coinciding decrease in the ratio low-frequency/high-frequency components of HRV, which reflects a greater balance of parasympathetic control of HRV, was observed (Chatow et al. 1995; Clairambault et al. 1992; Hunt 2006; Khattak et al. 2007; Krueger et al. 2010a; Longin et al. 2006; Sahni et al. 2000). Next to these, of current interest in preterm infants are also studies on exploration of the interrelations between bradycardia i.e. parasympathicus activity and enteral feeding (showing evident elevated baseline parasympathetic activity in feeding bradycardia, inhibition of the sympathetic nervous system and no changes in parasympathicus activity in response to the gut stimulus) (Veerappan et al. 2000; Smith et al. 2005; Brown, 2007). Recently, the cumulated effect of prematurity and prenatal exposure to nicotine on autonomic heart rate control, both recognised as risk-for-SIDS increasing factors, was investigated (Thiriez et al. 2009). One study explored the influence of electromagnetic fields produced by incubators on heart rate variability of newborns (Bellieni et al. 2008).

Several studies on HRV in preterm infants attempt to find out correlations between different HRV components and other physiological parameters such as blood pressure (correlates with high-frequency oscillations of HRV) and respiration (correlates with low-frequency oscillations of HRV) (Rassi et al. 2005). Preterm infants with respiratory distress syndrome (RDS) seem to have both low and high frequency oscillations of HRV abnormally low (Aarimaa et al. 1988), whereby in neonates receiving artificial ventilation, the correlation between HRV and respiration depends on the type of the ventilation involved (Rassi et al. 2005). Correlations were found also between EEG burst-to-burst intervals and heart rate accelerations in preterm infants (Pfurtscheller et al. 2005a; Pfurtscheller et al. 2005b; Pfurtscheller et al. 2008).

The correlations between different HRV components and pain responses as attempts: (i) to identify a variety of HRV patterns as response on a painful event, (ii) to establish connection between behavioural responses to pain and HRV patterns, as well as (iii) to identify a variety of response patterns and mechanisms that influence pain reactivity, are subject of some further studies on HRV in preterm infants (Allegaert et al. 2005; Oberlander & Saul 2002; Oberlander et al. 2002; Hanna et al. 2000, Khattak et al. 2007). The first results considering correlations between type of perinatal brain injury and specific pattern of HRV are opposite (Oberlander et al. 2002b; Hanna et al. 2000), implying that understanding cardiovascular reactivity as a measure of response to painful events in vulnerable infants requires ongoing work. A case report, on HRV changes in an infant with intraventricular hemorrhage, was recently published (Krueger et al. 2008).

Very few studies on heart rate variability in preterm infants investigated the effects of stress reducing interventions in neonatal intensive care unit (NICU) yielding controversial results. A case study on HRV response of a preterm infant to kangaroo (skin-to-skin) care showed changes in HRV that illustrate decreasing stress (McCain et al. 2005). In a recent pilot study it was shown that kangaroo care modifies preterm infant HRV enabling more autonomic stability in response to a painful procedure (Cong et al. 2009). Another study on effects of kangaroo care on HRV of preterm infants showed that kangaroo care had no severe side effects of prolonged tilting in stable preterm infants (whereby the initial decline of total haemoglobine, measured by near infra-red-spectroscopy, might be critical in very immature infants ≤ 1500g) (Schrod & Walter 2002). Anyway, a relative increase in sympathetic (versus vagal) activation was registered. An older study (Mazursky et al. 1998) showed no significant change in HRV in preterm infants following head-up tilt compared with baseline. A more recent study on massage for premature infants as possible stress reducing intervention in NICU vs. standard NICU care (Diego et al. 2007) showed that HRV increases with massage (moderate pressure massage therapy), whereby increases in vagal activity and gastric motility may also underlie the effects of massage therapy on preterm infant weight gain.

Studies on effect of music, mother's voice or any other acoustic stimulation on heart rate variability in infants and children have not been published up to now.

This is, to our knowledge, the first study that compares effect of lullaby music and mother's voice as acoustic stimulation interventions on heart rate variability of preterm infants. Moreover, this is the first study trying to find out the correlations between infants' and maternal well-being parameters.

In this investigation, we found that *both* lullaby music and mother's voice decreased heart rate and increased heart rate variability measures in premature infants *during* the acoustic stimulation (Table 10.1.). The results of the study are therefore speaking in favour of our first hypothesis, showing that *during* the acoustic stimulation *both* lullaby music and mother's voice can have a calming effect on preterm infants.

The findings about the calming effect of music on heart rate variability found in our investigation are in concordance with results of the studies that noted faster reduction of heart rate and shorter recovery from a stressful event in the presence of music (Burke et al. 1995; Franck & Miaskowski 1997; Butt & Kisilevsky 2000; Bo & Callaghan 2000). These findings are also in concordance with other results of these and other studies that reported beneficial effects of music on other stress-induced physiological reactions, such as studies that showed increased oxygen saturation levels (Burke et al. 1995; Standley & Moore 1995), increased transcutaneous oxygen levels (Franck & Miaskowski 1997), increased cerebral oxygen saturation levels (Linderkamp et al. 2004), reduced stress behaviour (Caine 1991) and facial expressions of pain (Burke et al. 1995; Franck & Miaskowski 1997; Butt & Kisilevsky 2000), as well as facilitation of pain management (Franck & Miaskowski 1997; Bo & Callaghan 2000; Standley 2003; BMJ Publishing Group & Royal College of Pediatrics and Child Health 2003) in the presence of music.

Contrary to these calming observations, the study on effect of music on heart rate variability in healthy adults (Urakawa & Yokoyama 2005) showed that rest with (preferred) music after exercise (compared to rest without music) enhances exercise-induced sympathetic dominance (increased ratio of low frequency to high frequency of heart rate variability), thus indicating that the music possibly synchronised with the activated physical response and further enhanced the exercise-induced sympathetic nerve activity.

The findings about the calming effect of mother’s voice as acoustic stimulation and/or intervention in NICU on heart rate variability that were found in our investigation are in concordance with the mentioned case study of McCain et al. (2005) and the pilot study of Cong et al. (2009), testing for HRV changes during kangaroo (skin-to-skin) care of preterm infants as well as with the study of Diego et al. (2007), testing for HRV changes during massage for preterm infants, confirming thus the positive, i.e. stress reducing effect of the parental involvement in NICU. It seems obvious that a stress reducing intervention aiming at the sense of touch, i.e. the contact with the body of the mother itself, has a very powerful effect on preterm infant, which most probably occurs via oxytocin release and distribution, and can be well registered by HRV changes. Nevertheless, a very recent study found a strikingly similar oxytocin release profile in children comforted solely by their mother’s voices, suggesting thus that in humans not only body contact but also social vocalisation can release oxytocin (Seltzer et al. 2010). Kangaroo (skin-to-skin) care, both maternal and paternal, has already/previously been well documented for stability of heart rate as well stability of respiration, oxygen saturation and energy balance (Bauer et al. 1996; Fischer et al.

1998). However, as side effect, it was noticed that boys show less cardiorespiratory stability compared to girls both in the incubator and during kangaroo care.

These gender differences observations were also found in the very latest study on HRV in preterm infants, showing that the high-frequency components of HRV for females increased with increasing age or displayed a pattern of HRV indicative of a more mature autonomic nervous system, thus speculating that the maturation of autonomic nervous system is gender dependant (Krueger et al. 2010a).

The preliminary results of this, still ongoing study, "HRV and Learning in Preterm Infants" (Krueger et al. 2010a; 2010b) included also repeated acoustic stimulation of preterm infants with mother's voice whereby the authors cannot state at this time whether regular exposure to CD recordings of maternal voice directly affected HRV. The experimental infants experienced, however, significantly fewer episodes of feeding intolerance and achieved full enteral feeds quicker than the control group (Krueger et al. 2010b).

Concerning the comparison of the calming effects of acoustic stimulation interventions, the most appropriate analysis to test this (second) hypothesis in our study design was considered the two-way ANOVA analysis of variance, testing both for factors "acoustic stimulation" and "time" as well as for the interaction effect between acoustic stimulation and time. The results of this comparison analysis are speaking in advantage of the mother's voice, i.e. the calming effect of the mother's voice was more pronounced (Table 10.1.). Moreover, analysing the affected HRV measures, it can be seen that the mother's voice increased the overall HRV indices which reflect long-term components of HRV and circadian rhythms variations whereby lullaby music increased the HRV indices which correspond to short-term, predominantly vagally mediated, changes of HRV. Multiple studies have demonstrated that short-term measures of HRV rapidly return to base after transient perturbations whereby more powerful stimuli may result in a much more prolonged interval before return to control values (Task Force of the European Society of Cardiology and the North American Society of Pacing Electrophysiology 1996). According to that, the mother's voice can be considered as a powerful stimulus.

Beyond our expectations, further findings of our study revealed decreased heart rate and increased heart rate variability measures in preterm infants not only *during* but also *after* mother's voice acoustic stimulation. These results are showing that the (beneficial) calming effect of the mother's voice persists over the time, maintains also after the acoustic intervention is over, which undoubtedly gives the mother's voice a big advantage over lullaby music.

These findings of long-lasting beneficial effects of mother's voice are in concordance with the results of the study which showed that auditory stimulation of premature infants with their mothers' voices improved language and overall development of these infants as assessed at pre-school age (Nöcker-Ribaupierre 1995; Nöcker-Ribaupierre 2003), as well as with the study which showed that vocal responsiveness of the mother to the infant's distress resulted in better reading and conversations skills of the child at school age (Coates & Lewis 1984).

10.2.2. Discussion of parental stress, parental competence and family functionality

Further results of our study do concern parental stress, i.e. parental burden and resources, both of them assessed by Parental stress scale, parental competence assessed by Parental competence scale as well as functionality of the family assessed by Family Assessment Measure.

The parents of the preterm infants in our study assessed their burden, resources and competence comparably as high as the parents of preterm infants in (two) other studies that used the same questionnaires in neonatal intensive care units (Vonderlin 1999, Jotzo 2004).

In the study of Vonderlin (1999), the parents of preterm infants reported higher levels of stress when compared with the parents of full-term infants. This higher stress appraisal resulted from the higher burden appraisal whereby no differences were found in the appraisal of resources between parents of preterm and full-term infants. Reported level of burden was the highest in parents of infants with very low birth weight (≤1000g). Parents of infants with birth weight >1500g did not differ from parents of full-term infants in their stress appraisal. There were no differences between mothers and fathers of preterm infants in stress appraisal, neither in burden nor in resources. In the study of Jotzo (2004), an early psychological intervention (one-off crisis intervention) addressing the parents of preterm babies (during hospitalisation in a neonatal intensive care unit) was shown to be effective in lowering the maternal feelings of burden when compared to the non-intervention group. Also in this study no differences were found in resources level between the intervention and non-intervention group.

Reported burden of parents of preterm infants was, anyway, lower than expected from the author of the Parental stress scale herself. She noted that it could be possible that this scale does not involve all the important aspects of stress and therefore underestimates the real parental burden. However, very few empirical data (findings) with these scales, available so far, do not allow the estimation of the real level of the burden, resources and competence.

In the investigations that used other instruments (The Parental Stressor Scale: Neonatal Intensive Care Unit) (Affleck et al. 1991; Thompson et al. 1993; Sarimski 1996) the mothers of preterm infants reported high burden levels. Their major concerns were for the infant's survival rather than their own welfare (Pederson et al. 1987).

The parents of premature infants are under the amount of stress. A growing literature (Rich-Edwards & Grizzard 2005; Wadhwa et al. 2001; Wadhwa 2005) views this stress from a different perspective. The stress which the mothers of premature infants experience is considered not only as the consequence but also the cause for the premature birth. Chronic exposure to psychosocial stress (psychological, emotional and social stress) may condition stress responses and physiologic changes in ways that increase the risk of preterm delivery. Cumulative stressors may impact pregnancy outcomes through several intersecting pathways, which include neuroendocrine, behavioural, immune, and vascular mechanisms (Ruiz et al. 2003; Park et al. 2005; Gennaro & Hennessy 2003), many of these pathways also lead to chronic disease. These processes may bridge the experience of social adversity before and during pregnancy and therefore the biological outcome of preterm birth. The preterm delivery (and poor pregnancy outcome as well) could be considered as a part of chronic disease process (with roots in childhood, adolescence and early adulthood). Cumulative stress can be a „pre-pregnancy-primer“ for the premature birth, since it has already negatively shaped the reproductive health of the mother-to-be.

Moreover, not only stress before pregnancy but also stress during pregnancy (prenatal stress) as well as early postnatal stress exert a harmful effect on offspring. Hypothalamic-pituitary-adrenal axis seems to be one of the key factors mediating the effects of early life stress on the neuronal network and behaviour. An exposure of the rat mothers in the last trimenon of pregnancy to stress that they cannot escape from, as 'strong' stressor, alters endocrine stress response and postnatal development of hypothalamic-pituitary-adrenal axis function (Gruss et al. 2006). Parental separation and deprivation early in life also acts as a stressor: Brief stress exposure elevates level of glucocorticoids and synaptic density in limbic centres, whereby longer parental separation leads to stress-induced decrease of brain activity and synaptic density in limbic centres. Repeated stress exposure attenuates separation-induced increase in glucocorticoids in females but not in males (Gruss et al. 2006). Parental separation and deprivation early in life also alters development of limbic system synaptic density that corresponds to heightened emotionality and suggests this developmental period important in determining adulthood emotional well being (Sullivan et al. 2006).

As research in human behavioural perinatology has shown, maternal prenatal stress has a significant and independent role in the aetiology of prematurity-related outcomes. These effects are mediated, in part, by the maternal-placental-foetal neuroendocrine axis, and specifically by placental corticotrophin-releasing hormone. Via stress-related psychoneuroendocrine processes in human pregnancy, maternal environment exerts a significant influence on the foetal neurodevelopmental processes related to recognition, memory and habituation, and health outcomes. The influence of prenatal stress and maternal-placental hormones on the developing foetus may also persist after birth, as assessed by measures of temperament and behavioural reactivity (Wadhwa 2005). Maternal emotional stress in pregnancy has been shown to have an epigenetic impact on infant's affective reactivity to novelty, i.e. maternal prenatal emotional stress alters early infant distress to novel unfamiliar stimuli (Möhler et al. 2006). High levels of emotional stress (measured by the prenatal emotional stress index) during pregnancy influence infant emotional development towards low affective reactivity to novelty. Low reactive infants tend to be disinhibited in the face of novelty, show low latency approach behaviour and typically develop into extraverted, novelty seeking children. High reactive infants, who are experiencing early distress to novelty with crying and vigorous movements in response to unfamiliar stimuli, show a higher rate of behavioural inhibition, more often display shy and withdrawn behaviour and have a higher rate of social anxiety.

Also postnatal maternal anxiety was shown to be related to infant neurological condition whereby paternal was not. Infants of mothers with high trait anxiety (assessed for the period of the first 12 months after birth by subfertile couples) have an increased vulnerability to develop a non-optimal nervous system (Kikkert et al. 2010).

Concerning the parental competences, the parents of the preterm infants in our study assessed their competences comparably as high as the parents of preterm infants in the study that used the same Parental competence scale (Vonderlin 1999). Parents of preterm infants assess their competence as high as the parents of full-term infants (Vonderlin 1999).

The parental competence in handling the own baby and social interaction with it seem to be important not only for the actual situation in NICU, but also for the development of later mother-infant interaction. In the investigation of Zahr & Cole (1991), parental competences, assessed by The Boston City Hospital Assessment of Parental Sensitivity, proved to be good predictors for the mother-infant-relationship at later infant's age, since scores obtained on competence assessment scale correlated with mother-infant interaction behaviours scores when infants were 8 months old. Thus, the assessment of maternal competence and sensitivity to premature infants' cues in the NICU, was shown to have both concurrent and predictive validity for the mother-infant relationship long after the discharge of the infant.

Parental competences can be compromised, merely by prematurity (Papoušek 2000) (see Chapter 3) or even solely by parental experience of the delivery. If the delivery is experienced as psychic burden or even trauma, either objective or subjective sensed, this event can compromise the parental competences and thereby contribute to a development of dysfunctional mother/parent-child interaction (Thiel-Bonney & Cierpka 2004; Pierrehumbert et al. 2003). These traumatic experiences of the premature birth can have a long-lasting effect on the mother-infant interaction. The interaction pattern that is developed short after the birth often seems to persist over childhood (Papoušek & von Hofacker 1998). Behavioural pattern of the premature born infant in the mother-child interaction at a later time seems to correlate with the strength of the traumatic experience of the mother (Muller-Nix et al. 2004; Bakewell-Sachs & Gennaro 2004; Swartz 2005).

However, these interaction patterns can be influenced by interventions which support and encourage mother's competence in recognition of infants' signals or improve the social stimulation of infant and/or the integration of the family (Whitfield 2003).

As both biological and psychosocial factors have an effect on the mother's experiences, it is necessary to evaluate previous maternal experiences and coping resources and offer practical counselling for the mothers to optimise the clinical care in the future (Ganseforth et al. 2002). Trauma-preventive psychological interventions for premature parents helping them to cope with the trauma of premature birth (Jotzo & Poetz 2005) reduce the symptoms of traumatisation relating to premature birth. Psychotherapeutical interventions based on the moment-to-moment interactive process which produce the ‚fitting together' between the mother and her premature born baby step by step (Bruschweiler-Stern et al. 2002) help the premature mother to connect with her infant and lead to changes in her implicit knowledge through alteration of emotional procedure (Stern et al. 1998; Stern et al. 2001). By establishing a safe holding environment and a positive therapeutic alliance, firstly, and by recognising the vulnerability of premature mother through the caring person that acts like a doula during the immediate postnatal period, an early emotional care for mothers and infants in clinical setting can be provided. This care focuses on the specific match between the real and imagined babies and helps the premature mother to connect with her infant, promoting thus “the birth of the psychological mother” (Bruschweiler-Stern 1998, Bruschweiler-Stern N 2009). Music therapy improvisations have been found to facilitate the genesis of these specific moments between interacting partners (Schwaiblmair 2008).

An early promoter of parental feelings of competence in NICU seem to be the kangaroo care, since the mothers practicing kangaroo care feel more competent than the mothers in the traditional care group (Tessier et al. 1998; Doyle 1997).

The promotion of parental competences is also of importance for the success of all so called family-centred interventions for premature infants in NICU, since this success is often dependent upon intuitive parental competence and their (as fine as possible) tuning into premature infants’ needs.

Family-centred interventions at NICU seem to be effective for both stress-reduction of infants and appropriate for the improvement of the parental knowledge and behaviour pattern. Preterm infants who receive individualized, developmentally supportive family-centred care demonstrate fewer behavioural stress cues and show comparable short-term outcomes and resource utilisation than infants who receive only routine care (Byers et al. 2006). Interventions in NICU aiming at mothers’ either theoretical or practical education brought up evidenced greater knowledge and more contingent and sensitive interactions with premature infants (Browne & Talmi 2005).

An individual care for an infant and his family (Linderkamp 2005a, 2005b, 2005c), in order to promote the optimal development of premature infants, is also needed in NICU. If the physiological and development promoting stimuli are offered at NICU, the prognosis and outcome of the preterm infants improves essentially (Linderkamp 2005a, 2005b, 2005c). The care according to the Newborn Individualized Developmental Care and Assessment Program® (NIDCAP®), which among other things recognises and promotes the individual self-regulation of the baby, enables an optimal development of premature infants (somatic as well referring to brain development) despite intensive medical treatment. Moreover, through this concept, both child behaviour and mother-child interaction are positive affected (Als et al.

1982; Als et al. 1994; Als et al. 1996, Als 1999; Als et al. 2004; Kleberg, Westrup & Stjernqvist 2000; Kleberg et al. 2002).

Meeting the social support needs of a mother is important for her own mental and physical health and well-being. It also helps her meet social and developmental needs of her infant (Logsdon & Davis 1998).

As the major support for the mothers of preterm infants staying in NICU were found to be their husbands, parents and, for its members, church (Pederson et al. 1987).

The parents of the preterm infants in our study assessed the functionality of their family, as mentioned, on average within the normal range on the Family Assessment Measure, although there were families with scores below and above normal range.

The family functionality is considered as a protective factor, since it can be assumed that one crisis mobilises the general family resources (Cierpka 1996; Cierpka 2008).

One of the three main tasks of the family is, besides basic existential tasks and developmental tasks, the mastering of crisis situations (Cierpka 2008). The extent of family functionality is especially visible in the ability of adaptation to altered states (Cierpka 1996; Cierpka 2008). The birth of the first child brings changes for the couple relationship in the family life cycle (Frevert et al. 1996; Fthenakis et al. 2002). With the arrival of the first child the couple will have to negotiate tasks and functions once again. Considered structurally, a transition from the dyadic to the triadic relationship takes place (Frevert et al. 1996). Parallel to the transition from the dyadic to the triadic relationship also the transition from the imagined to the real child takes place (von Klitzing 1998). Many connections have been found between the already prenatal existing relationship of one parent to the child and the other partner and those triadic relationships after the birth (von Klitzing 1998).

Not only the parents show triangular capacities, but also an infant shows triangular capacity, i.e. the capacity to simultaneously communicate with both parents (Fivaz-Depeursinge 1998; Fivaz-Depeursinge & Corboz-Warnery 2001). This capacity is usually in the service of infant's own developmental goals, whenever the triadic relationship has the characteristic of an alliance. When instead of an alliance, a coalition exists, especially when coparenting is hostile-competitive, there is role reversal and the infant's triangular capacities are used to relieve the tension between the parents and regulate the parents' relationship (Fivaz-Depeursinge & Favez 2006; Fivaz-Depeursinge et al. 2007; Fivaz-Depeursinge et al.

2009). However, in the families showing evidence of better coparental adjustment, the infants belonging to these families exhibit more advanced triangular capacities (McHale et al. 2008).

In case of premature birth, the family stress, as a disturbance of the family steady state (Boss 2002), can result in the family crisis. A family crisis is (i) a disturbance in the family's equilibrium that is so overwhelming, (ii) a pressure that is so severe, or (iii) a change that is so acute that the family system is blocked, immobilized, and incapacitated (Boss 2002).

One has also to have in mind, that modern family life forms are nowadays already more susceptible to crisis, solely due to increased tendencies of autonomy combined at the same time with the increased desire for exclusive relationship and family (the so called "increased family feeling") (Cierpka 2005). Society requires higher level of job dedication which in return brings stronger desires for and from family surrounding. The expectations of family life are thereby higher – the family should compensate for all the tensions and discontent in working area. Thereby emerge new conflicts and the modern family life form can easily be overstimulated (Cierpka 2005).

In the case of premature birth, as in any family crisis, the family functionality represents an important resource concerning mutual parental and partnership support. The adaptation to the new situation and understanding between the partners regarding new tasks and family roles can be facilitated, especially if openness exists between partners for the needs of each other and emotional exchange represents an essential part of the relationship (Frevert et al. 1996). Just as well, social support through other family members can also be a protective factor at the time of transition to premature parenting.

10.2.3. Discussion of correlations between heart rate variability of preterm infants and mothers' stress, competence and functionality of family

Our further investigation followed up if the interrelations between the well-being of the mother and the heart rate variability of premature exist.

As previously mentioned, we found that the mother's voice can calm down the baby, i.e. the heart rate variability of the baby increases *during* as well as *after* acoustic intervention with the mother's voice. With reference to relationship between burden, resources and competences of the mother and her assessment of the family functionality, on the one hand, and different heart rate variability measures of her premature born infant, on the other hand, multiple significant correlations were found. These findings indicate a narrow interrelation between well-being of the mother and heart rate variability as baby's well-being indicator.

According to the expectations, a higher family functionality is associated with a higher heart rate variability of the baby.

The values of the standard scale "Control" correlate negative with the HRV measures. According to that HRV arises with diminishing accentuation of the control in the family. Low scales values in the family questionnaire indicate strengths in the family. Values lower than 50 in the scale "Control" mean: "The forms of influences allow that the family life passes off in the manner that is agreed with ideas of all family members, so that the control behaviour is predictable, but still flexible enough. Spontaneity is allowed in a certain frame, control attempts act constructive, instructive and growth stimulating"(Cierpka & Frevert 1994, p. 48).

Values of the control scale "Defence" correlate also negative with HRV measures, which indicates an increase of the HRV with lesser defence values, i.e. an increase of the HRV with increase of „defence strengths". The bigger the HRV of the child is the more seems the family to emphasise its resilience.

Against the expectations, it was shown that a higher burden and less resources as well as less competence of the mother were associated with a higher HRV of the premature baby.

The functionality of the family that got a premature baby as well as the influence of the well-being of the mother/parent on stress reduction of the premature babies has been barely investigated so far. The results of this study indicate that the functionality of these families is in normal range. This finding is in concordance with a study of Sarimski (1996), in which 70% of the mothers stated that their partnership has become even stronger through the crisis of premature birth.

Investigations concerning the issue of interrelations between the mother's and child's well-being (Stern 1995; Stern et al. 1998) are also barely available up to now. The physiological correlates of a narrow relationship or a behaviour pattern (Ortiz & Raine 2004) were just as little described up to now. On the basis of this study, HRV could be presumed as such a correlate (between physiological parameter and behaviour). Also, the influences of an (acoustic) intervention on HRV of premature infants were not investigated scientifically up to now. In this respect, this study is the first of this kind, attempting to describe the physiological correlates of a mother-child-relationship, with HRV as a high innovative method.

The results of this study indicate a discrepancy between the well-being of the mother and her ability to calm down her baby. Different reasons could explain these findings:

In this study, it was assumed that the stress of the mother reflects in her voice. In this respect the voice i.e. vocal expression was understood as intuitive behaviour (Papoušek & Papoušek 1981b). Generally, the musical elements in our speech appear spontaneously and involuntary, without our record or control, often even against our will (Papoušek & Papoušek 1981b). Non-verbal speech contents are connected with limbic system and could be responsible for “misunderstandings”: If there is dissociation between the verbal and non-verbal message, the interactional partner notices most of the time merely the emotional level (Papoušek & Papoušek 1981b). An emotional state, a depressive mood, for example, could also be recognised in prosody of the voice (melody of sentence) (Garcia-Toro et al. 2000).

However, due to the findings, it seems that the mother‘s voice does not indicate her stress level so explicitly. One possible explanation for that could be that exactly those mothers who are under the highest burden/ under a lot of stress (because they have a high-risk baby), are the most motivated are to do something (good) for their needy babies. It could be that exactly these mothers who are exhausted (high burden, low resources) quite consciously control their vocal expression during reading a fairytale and thereby influence/affect it favourable. The greater stress the mother subjective experiences is, the more she tries possibly not to let this be showed in her voice, thereby which she manages/succeeds to calm down the baby eventually better. Similarly as by depressive mothers, who can suppress and ignore own stress when in interaction with the baby, it could be possible and probably even easier for a psychic healthy mother to ignore own stress, when she is motivated and receives the opportunity to do something good for her child. If possible, she mobilises her resources and intuitive competence and can calm down her baby even better than the mother that does not experience such high burden (Laucht et al. 2002; Moscardino et al. 2006). So, this would be the motivation theory.

Another possible explanation could be that exactly those mothers, who better calm down the baby, are capable of greater empathy with own child, which in return makes them feel greater actual burden. This idea could be supported by the study of Browne & Talmi (2005), who found that the mothers who underwent educational interventions in NICU reported greater stress scores than control group. This theory would be in concordance with the motherhood constellation (Stern 1998), which suggest that with the birth of a baby, especially the first, the mother passes into a new and unique psychic organization, in which her major preoccupation are her discourse with her own mother, especially with her own mother-as-mother-to-her-as-child, her discourse with herself, especially with herself-as-mother, and her discourse with her baby. This so called mother's trilogy requires the greatest amount of mental work and mental reworking. It enables the new mother to understand own child and share his/her feelings or experiences by imagining what it would be like to be in his/her situation (empathy), but also to attune to the child's needs regressively. This psychic organization that emerges during the phase of motherhood constellation may be permanently evocable. It would be interesting to investigate the acoustic stimulation with the father's voice to check these theories (motivation or motherhood constellation).

Furthermore, to what extent the fact that the voice of the mother was recorded on audio-tape, affected HRV changes seems to matter, is also unclear. Because the mothers were free to determine the recording time, they have probably chosen the moment when they felt better, i.e. felt comparatively less under burden.

Another possible explanation for the findings that not agree with our expectations could be that the mothers represent their competence and resources in questionnaires in certain way, in order to be able to cope with the very burdening situation. For this assumption plead high values on scale ‚Defence'. Even though in normal range, these values are still on transition to distortion, which indicates that these parents emphasise their ability to manage the situation. This could mean that parents who have a high-risk baby protect themselves by emphasising their competence and resources and suppress or deny their stress.

Of course, independent of these considerations, our finding could also imply that generally there are babies that are easy to calm down and babies that are not easy to calm down and the results of the study have more to do with the temperament of the baby or its self-regulation ability than with the mother's well-being.

10.3. Conclusions, value of the study and clinical implications

Based on our study, the following conclusions can be drawn:

- In comparison with control situation, both acoustic stimulation interventions induce HR decrease, i.e. HRV increase in preterm babies *during* the acoustic stimulation intervention.

- Statistically significant increase in HRV was however shown only *during* mother's voice acoustic stimulation.
- Calming effect of the mother‘s voice maintains also *after* the acoustic stimulation intervention, i.e. mother‘s voice has a prolonged / lasting effect.
- The correlations between the mother‘s well-being and their infants' HRV indicate a strong relationship.
- A higher family functionality is associated with a higher HRV of preterm babies.
- Contradictory to the expectations, higher burden and lower resources as well as lower competences of the mother‘s were associated with a higher HRV of preterm babies.

Concerning the implications, mothers should be encouraged to interact (more) with their preterm infants. A mother of an infant in NICU should be encouraged to speak to her baby, to sing and to read to him. She should be enabled to record her voice for the moments when she is not at the NICU and the personnel could have the need to calm down the baby. In the absence of the mother or for the painful procedures which do not allow mother's presence, lullaby music at 55-65 dB could be also helpful in calming down the preterm baby.

10.4. Limitations of the study and perspectives for future research

This is the preliminary study on effect of mother's voice and lullaby music on heart rate variability. Therefore, the findings of our study on prolonged beneficial effects of mother's voice indicate the need for further investigations on effects of repeated acoustic stimulation interventions with mother's voice as well as investigations on long-term effects of mother's voice.

Statistically, our sample size is small. In order to give the appropriate advices for the clinical praxis, the study design should be replicated in a bigger sample. The bigger sample could also enable subgroup analyses and enlighten the discrepancies in our study and controversial results in the quoted studies as well as the possible role of the individual self-regulation of infants.

There are also some methodological limitations. Randomly cut our two minutes data sections are probably not the real counterpart to each other. It would make sense to choose two minutes data sections which are equally far from the start of the acoustic stimulation intervention, since preterm infants could be overstimulated in short time.

Reading a fairytale without having the possibility to interact with the child directly at that moment and possibly not being able to adapt and fine tune own competences to the infant’s needs at the moment is another limitation of the study. Instead of reading a fairytale a live mother-baby interaction would be better for the parental tuning on infant’s needs. By investigating the real-time effect of mother’s voice in a live interaction between mother and her baby would be probably obtained the most valuable information on correlation between mother’s and infant’s well-being. Also, it would be good to register HRV of the mother and of the baby simultaneously. Therefore, simultaneous real-time investigations of the mothers‘ and the babies‘ HRV during a live mother-baby interaction seem to be necessary to provide further explanations of noticed correlations between the mother‘s stress, her competence feelings and their babies‘ HRV.

PART FIVE: **SUMMARY**

Premature Born Infant's Reaction to the Mother's Voice in Comparison to their Reaction to Music - Effect on Heart Rate and Heart Rate Variability -

OBJECTIVE: The aim of the study was to compare stress-reduction effects of the mother's voice and lullaby music in preterm infants and to explore whether the mother's well-being affects her ability to calm down her preterm baby. It was hypothesized that both acoustic stimulation interventions in comparison with a control (no-acoustic stimulation) situation can calm down the baby, i.e. decrease heart rate and increase heart rate variability in preterm infants. Further it was hypothesized that the mother's voice would have greater effect than lullaby music. Furthermore it was hypothesized that the mother´s voice from a mother who manages her current stress better, who feels more competent in parent-child interactions and who has a more functional family will have the greatest effect.

PATIENTS AND METHODS: Thirty preterm infants with gestational age of 27 to 36 weeks were acoustically stimulated with the voice of their own mother (reading favourite fairytale) and lullaby music at a postnatal age of 3 to 5 weeks when their cardiorespiration was stable (corrected gestational age 30-41 weeks). Acoustic stimulation with the mother's voice and lullaby music was done on two consecutive days. The order of the two acoustic stimulations was randomly assigned for each infant. A continuous electrocardiogram was recorded by polysomnography device 15 minutes before, 15 minutes during and 15 minutes after the acoustic stimulation. Various heart rate variability measures (NN interval mean value, NN interval median, variance of NN intervals, standard deviation of NN intervals, pnn 6,25, RMSSD, SDSD and RSA) were assessed. Behavioural states were differentiated both by clinical observations according to Prechtl and a PC software program. Non-REM sleep sections of 2 minutes duration (randomly cut out from the respective data sections in the continuous electrocardiogram) were matter of analyses. In order to study a possible influence of the mother's well-being on the calming quality of her voice and thereby on the heart rate variability of her preterm infant, maternal/paternal stress and competences as well as family functionality were assessed via respective questionnaires. Two-way repeated measures ANOVAs, testing for the factor "acoustic stimulation", the factor "time" as well as for the interaction between these two factors, was considered as the most appropriate to test the hypotheses. For the interrelations between well-being of the mother and heart rate variability of her preterm infant, Pearson correlations were conducted.

RESULTS: Heart rate and heart rate variability of preterm infants showed no statistically significant differences *before* acoustic stimulation. *During* acoustic stimulation, both music and mother's voice decreased heart rate and increased different heart rate variability measures. However, statistically significant differences were found for NN interval mean value *during* mother's voice. Beyond expectations, statistically significant differences were found also for NN interval mean value and NN interval median value *after* acoustic stimulation with mother's voice, suggesting thus a prolonged or lasting effect of the mother's voice. Concerning well-being parameters of the mothers', the level of reported burden was elevated. Other well-being parameters of these premature mother's (resources, competences and family functionality) were within the normal range. The correlations between the mothers' well-being and their babies' heart rate variability *during* and *after* fairytale acoustic stimulation indicate a strong relationship. The correlations point out that a higher family functionality is associated with a higher heart rate variability of preterm babies. Contradictory to the expectations, higher burden and lower resources as well as lower competences of the mothers were associated with a higher heart rate variability of the preterm babies.

CONCLUSIONS: In comparison with control situation, both acoustic stimulation interventions induce heart rate decrease, i.e. heart rate variability increase in preterm babies *during* the acoustic stimulation intervention. Statistically significant increase in heart rate variability was however shown only *during* mother's voice acoustic stimulation. The calming effect of the mother‘s voice maintains also *after* the acoustic stimulation intervention, i.e. mother‘s voice has a prolonged / lasting effect. The correlations between the mother‘s well-being and their babies‘ heart rate variability indicate a strong relationship. A higher family functionality was associated with a higher heart rate variability of preterm babies. Also higher burden and lower resources as well as lower competences of the mother‘s were associated with a higher heart rate variability of preterm babies.

Mothers should be encouraged to interact (more) with their preterm infants. Simultaneous real-time investigations of the mothers' and the babies' heart rate variability during a live mother-baby interaction seem to be necessary to provide further explanations of the noticed correlations between the mother‘s stress, her feelings of competence and their babies‘ heart rate variability.

PART SIX: **LITERATURE**

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In: Nöcker-Ribaupierre M: Hören – Brücke ins Leben.
Vandenhoeck & Ruprecht, Göttingen

PART SEVEN: **APPENDIX**

The prevalence of prematurity in the world (I-IV)

Country/Region	Extrapolated Incidence	Population Estimated Used
Premature Birth in North America (Extrapolated Statistics)		
USA	475,030	293,655,405[1]
Canada	52,586	32,507,874[2]
Premature Birth in Europe (Extrapolated Statistics)		
Austria	13,223	8,174,762[2]
Belgium	16,739	10,348,276[2]
Britain (United Kingdom)	97,496	60,270,708 for UK[2]
Czech Republic	2,015	1,0246,178[2]
Denmark	8,756	5,413,392[2]
Finland	8,435	5,214,512[2]
France	97,745	60,424,213[2]
Greece	17,223	10,647,529[2]
Germany	133,333	82,424,609[2]
Iceland	475	293,966[2]
Hungary	16,228	10,032,375[2]
Liechtenstein	54	33,436[2]
Ireland	6,421	3,969,558[2]
Italy	93,916	58,057,477[2]
Luxembourg	748	462,690[2]
Monaco	52	32,270[2]
Netherlands (Holland)	26,397	16,318,199[2]
Poland	62,483	38,626,349[2]
Portugal	17,024	10,524,145[2]
Spain	65,160	40,280,780[2]
Sweden	14,536	8,986,400[2]
Switzerland	12,052	7,450,867[2]
United Kingdom	97,496	60,270,708[2]
Wales	4,720	2,918,000[2]
Premature Birth in the Balkans (Extrapolated Statistics)		
Albania	5,734	3,544,808[2]
Bosnia and Herzegovina	659	407,608[2]
Croatia	7,274	4,496,869[2]
Macedonia	3,300	2,040,085[2]
Serbia and Montenegro	17,512	10,825,900[2]
Premature Birth in Asia (Extrapolated Statistics)		
Bangladesh	228,639	141,340,476[2]
Bhutan	3,535	2,185,569[2]
China	2,101,077	1,298,847,624[2]
East Timor	1,648	1,019,252[2]
Hong Kong s.a.r.	11,089	6,855,125[2]
India	1,722,908	1,065,070,607[2]
Indonesia	385,732	238,452,952[2]
Country/Region	**Extrapolated Incidence**	**Population Estimated Used**
Japan	205,979	127,333,002[2]
Laos	9,816	6,068,117[2]
Macau s.a.r.	720	445,286[2]

Appendix 1.1.

The prevalence of prematurity in the world (I-IV)

Malaysia	38,051	23,522,482[2]
Mongolia	4,450	2,751,314[2]
Philippines	139,508	86,241,697[2]
Papua New Guinea	8,768	5,420,280[2]
Vietnam	133,719	82,662,800[2]
Singapore	7,043	4,353,893[2]
Pakistan	257,523	159,196,336[2]
North Korea	36,716	22,697,553[2]
South Korea	78,025	48,233,760[2]
Sri Lanka	32,199	19,905,165[2]
Taiwan	36,801	22,749,838[2]
Thailand	104,929	64,865,523[2]
Premature Birth in Eastern Europe (Extrapolated Statistics)		
Azerbaijan	12,728	7,868,385[2]
Belarus	16,678	10,310,520[2]
Bulgaria	12,161	7,517,973[2]
Estonia	2,170	1,341,664[2]
Georgia	7,593	4,693,892[2]
Kazakhstan	24,497	15,143,704[2]
Latvia	3,730	2,306,306[2]
Lithuania	5,836	3,607,899[2]
Romania	36,163	22,355,551[2]
Russia	232,899	143,974,059[2]
Slovakia	8,773	5,423,567[2]
Slovenia	3,253	2,011,473 [2]
Tajikistan	11,342	7,011,556 [2]
Ukraine	77,213	47,732,079[2]
Uzbekistan	42,722	26,410,416[2]
Premature Birth in Australasia and Southern Pacific (Extrapolated Statistics)		
Australia	32,212	19,913,144[2]
New Zealand	6,460	3,993,817[2]
Premature Birth in the Middle East (Extrapolated Statistics)		
Afghanistan	46,125	28,513,677[2]
Egypt	123,131	76,117,421[2]
Gaza strip	2,143	1,324,991[2]
Iran	109,196	67,503,205[2]
Iraq	41,047	25,374,691[2]
Israel	10,027	6,199,008[2]
Jordan	9,076	5,611,202[2]
Country/Region	**Extrapolated Incidence**	**Population Estimated Used**
Kuwait	3,651	2,257,549[2]
Lebanon	6,110	3,777,218[2]
Libya	9,109	5,631,585[2]
Saudi Arabia	41,728	25,795,938[2]
Syria	29,144	18,016,874[2]
Turkey	111,446	68,893,918[2]
United Arab Emirates	4,082	2,523,915[2]
West Bank	3,738	2,311,204[2]

The prevalence of prematurity in the world (I-IV)

Yemen	32,393	20,024,867[2]
Premature Birth in South America (Extrapolated Statistics)		
Belize	441	272,945[2]
Brazil	297,810	184,101,109[2]
Chile	25,597	15,823,957[2]
Colombia	68,443	42,310,775[2]
Guatemala	23,100	14,280,596[2]
Mexico	169,787	104,959,594[2]
Nicaragua	8,670	5,359,759[2]
Paraguay	10,015	6,191,368[2]
Peru	44,556	27,544,305[2]
Puerto Rico	6,305	3,897,960[2]
Venezuela	40,469	25,017,387[2]
Premature Birth in Africa (Extrapolated Statistics)		
Angola	17,759	10,978,552[2]
Botswana	2,651	1,639,231[2]
Central African Republic	6,054	3,742,482[2]
Chad	15,429	9,538,544[2]
Congo Brazzaville	4,849	2,998,040[2]
Congo kinshasa	94,336	58,317,030[2]
Ethiopia	115,397	71,336,571[2]
Ghana	33,577	20,757,032[2]
Kenya	53,353	32,982,109[2]
Liberia	5,484	3,390,635[2]
Niger	18,377	11,360,538[2]
Nigeria	28,713	12,5750,356[2]
Rwanda	13,327	8,238,673[2]
Senegal	17,554	10,852,147[2]
Sierra leone	9,518	5,883,889[2]
Somalia	13,433	8,304,601[2]
Sudan	63,327	39,148,162[2]
South Africa	71,901	44,448,470[2]
Swaziland	1,891	1,169,241[2]
Tanzania	58,349	36,070,799[2]
Country/Region	**Extrapolated Incidence**	**Population Estimated Used**
Uganda	42,690	26,390,258[2]
Zambia	17,835	11,025,690[2]
Zimbabwe	5,939	1,2671,860[2]

Footnotes:
1. US Census Bureau, Population Estimates, 2004
2. US Census Bureau, International Data Base, 2004

Last revision: June 12, 2003
http://www.wrongdiagnosis.com/p/premature_birth/stats-country.htm
About these extrapolations of prevalence and incidence statistics for Premature Birth: These statistics are calculated extrapolations of various prevalence or incidence rates against the populations of a particular country or region. The statistics used for prevalence/incidence of Premature Birth are typically based on US, UK, Canadian or Australian statistics. This extrapolation calculation is automated and does not take into account any genetic, cultural, environmental, social, racial or other differences across the various countries and regions for which the extrapolated

Appendix 1.1.

The prevalence of prematurity in the world (I-IV)

Premature Birth statistics below refer to. As such, these extrapolations may be highly inaccurate (especially for developing or third-world countries) and only give a general indication (or even a meaningless indication) as to the actual prevalence or incidence of Premature Birth in that region.

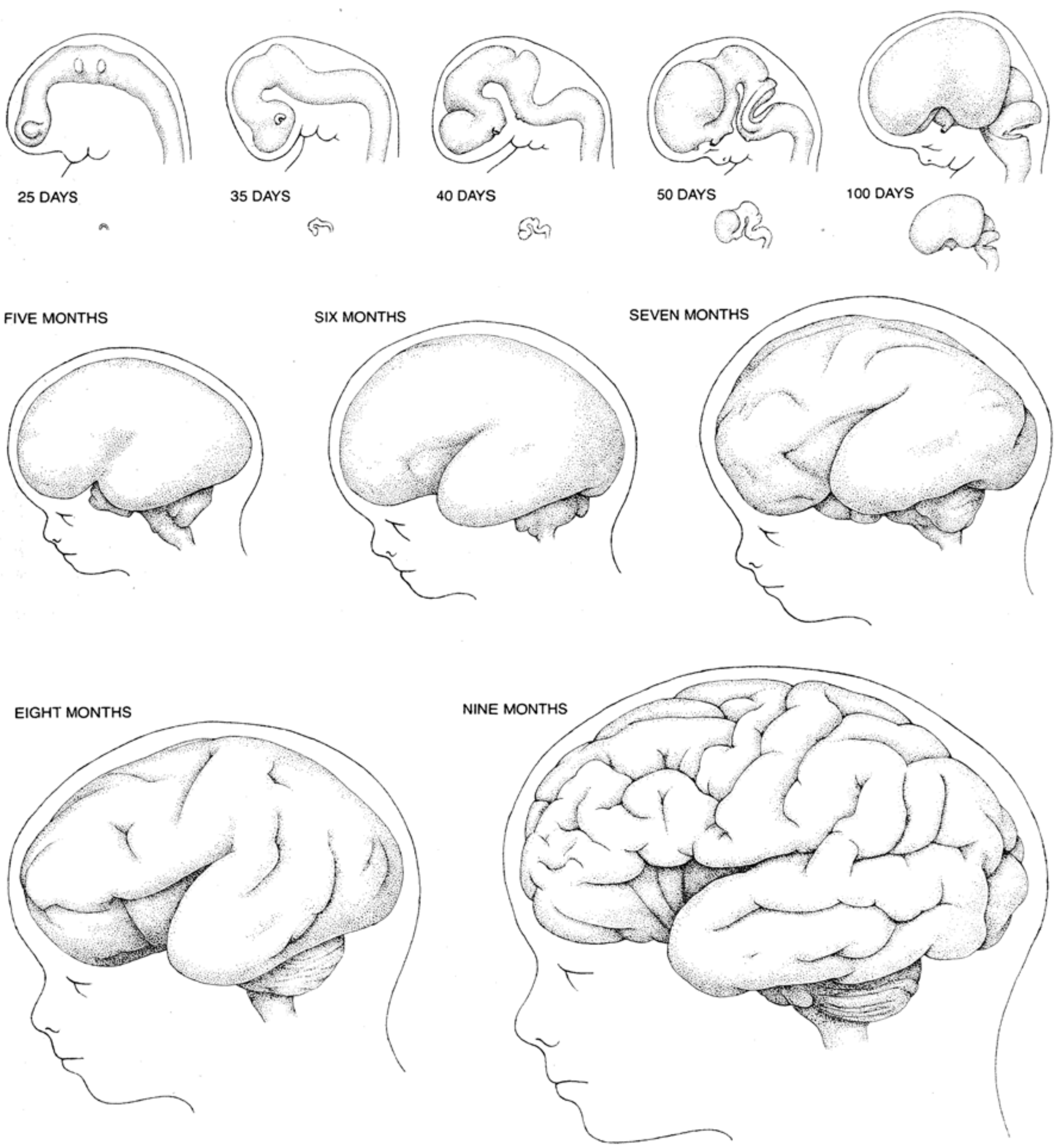
About prevalence and incidence statistics in general for Premature Birth: The word 'prevalence' of Premature Birth usually means the estimated population of people who are managing Premature Birth at any given time (i.e. people with Premature Birth). The term 'incidence' of Premature Birth means the annual diagnosis rate, or the number of new cases of Premature Birth diagnosed each year (i.e. getting Premature Birth). Hence, these two statistics types can differ: a short disease like flu can have high annual incidence but low prevalence, but a life-long disease like diabetes has a low annual incidence but high prevalence. For more information see about prevalence and incidence statistics.

Incidence (annual) of Premature Birth: 440,000 cases (unreliable estimate)

Incidence Rate for Premature Birth: approx 1 in 618 or 0.16% or 440,000 people in USA

Extrapolation of Incidence Rate for Premature Birth to Countries and Regions: The following table attempts to extrapolate the above incidence rate for Premature Birth to the populations of various countries and regions. As discussed above, these incidence extrapolations for Premature Birth are only estimates and may have limited relevance to the actual incidence of Premature Birth in any region.

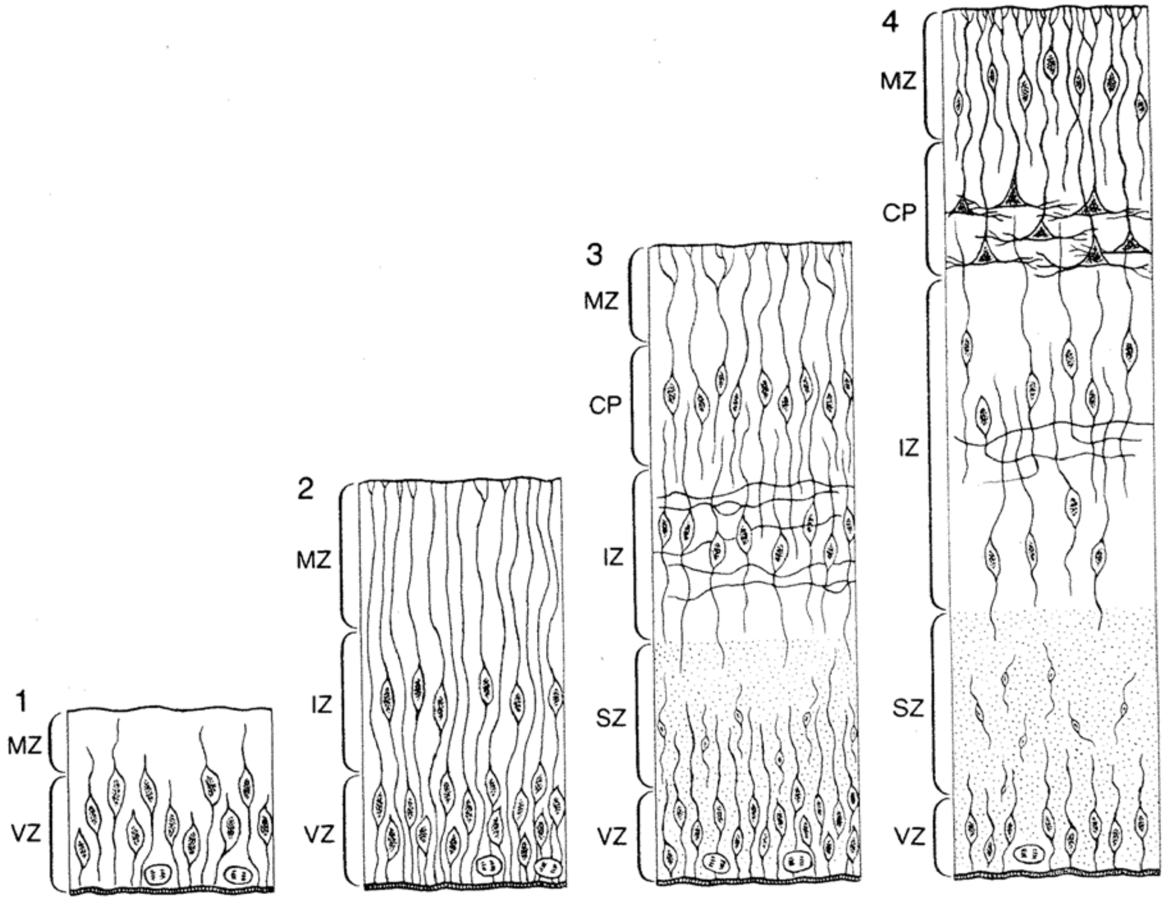
The development of the brain (according to Cowan 1979) (I-II)



Developing human brain is viewed from the side in this sequence of drawings, which show a succession of embryonic and foetal stages. The drawings in the main sequence (bottom) are all reproduced at the same scale: approximately four-fifths life-size. The first five embryonic stages are also shown enlarged to an arbitrary common size to clarify their structural detail (top). The three main parts of the brain (the forebrain, the midbrain and the hindbrain) originate as prominent swelling at the head end of the early neural tube. In human beings the cerebral hemispheres eventually overgrow the midbrain and the hindbrain and also partly obscure the cerebellum. The characteristic convolutions and invaginations of the brain's surface do not begin to appear until about the middle of pregnancy. Assuming that the fully developed human brain contains on the order of 100 billion neurons and that virtually no new neurons are added after birth, it can be calculated that neurons must be generated in the developing brain at an average rate of more than 250,000 per minute.

Appendix 1.2.

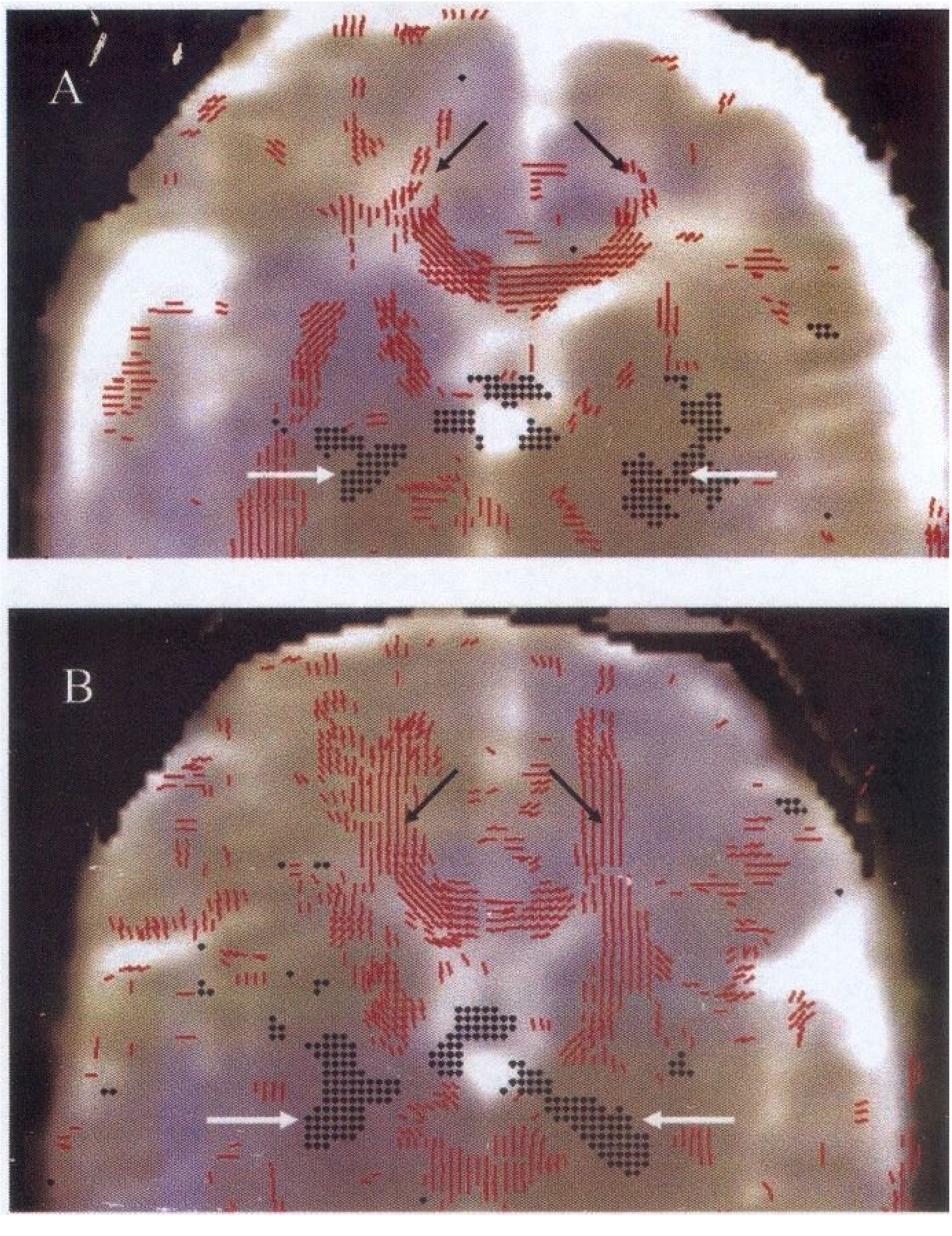
The development of the brain (according to Cowan 1979)



Progressive thickening of the wall of the developing brain is illustrated. At the earliest stage (1) the wall consists only of a “pseudostratified” epithelium, in which the ventricular zone (VZ) contains the cell bodies and the marginal zone (MZ) contains only the extended outer cell processes. When some of the cells lose their capacity for synthesizing DNA and withdraw from the mitotic cicle (2), they form a second layer, the intermediate zone (IZ). In the forebrain cells that pass through this zone aggregate to form the cortical plate (CP), the region in which the various layers of the cerebral cortex develop (3). At the latest stage (4) the original ventricular zone remains as the ependymal lining of the cerebral ventricles, and the comapartively cell-free region between this lining and the cortex becomes the subcortical white matter, through which nerve fibers enter and leave the cortex. Subventricular zone (SZ) is a second proliferative region in which many glial cells and some neurons in forebrain are generated.

Taken from: Cowan WM (1979): The development of the brain. Sci Am 241: 113-133

Early experience alters brain function and structure (according to Als et al. 2004) (I-II)



Neurostructural outcome (MRI DTI): Shown are examples of diffusion tensor maps from identical axial slices through the frontal lobes of a representative control group (A) and an experimental group (B) infant obtained at 2 weeks' corrected age. In each example, the principal eigenvectors (shown in red and black) overlie the apparent diffusion coefficient (ADC) map to show anisotropy in white matter. The red lines denote eigenvectors located

Appendix 1.3.

Early experience alters brain function and structure

(according to Als et al. 2004) (I-II)

within the plane of the image, and the black dots indicate eigenvectors oriented mostly perpendicular to the image plane. The ratio of E1/E3 has been used as a threshold to show only eigenvectors at those voxels where E1/E3 exceeds a threshold value of 1.3 in both images. Note **the greater anisotropy of white matter found in the experimental infant (B) as compared with the control infant (A)** at the posterior limbs of the internal capsule (white arrows) and the frontal white matter adjacent to the corpus callosum (black arrows). The greater anisotropy found in the experimental infant (B) suggests more advanced white matter development in these regions as compared with white matter found in the control infant (A).

Taken from: Als H, Duffy FH, McAnulty GB, Rivkin MJ, Vajapeyam S, Mulkern RV, Warfield SK, Huppi PS, Butler SC, Conneman N, Fischer C & Eichenwald EC (2004): Early experience alters brain function and structure. Pediatrics 113: 846-857

Appendix 4.1.

The recommended HRV-measures in the time- and frequency- domain (according to Patzak et al. 2002)

HRV measure	Mainly recorded frequency domain	Abbreviations, synonyms, units	HRV components Description	Sources
Time domain:				
Standard deviation of heart period durations	Low- and high-frequent	SDNN, SD (ms)	Includes the whole variability	Cabal et al. 1980, van Ravenswaaij-Arts et al. 1990, 1991, Prietsch et al. 1992, Äärimaa et al. 1985, Perticone et al. 1990, Schechtman et al. 1992
Average difference of two consecutive heart period durations	High-frequent	RMSSD (ms)	Covers mainly high frequently (breathing correlated) changes of HRV	
Respiratory sinus arrythmia	High- and middle frequent	RSA (ms)	Breathing correlated HRV	
Frequency domain:				
The whole power of the spectrum	The whole frequency spectrum	TP*	The whole variability of HR, correspond to variance in time-domain	Baldzer et al. 1989, Äärimaa et al. 1988, van Ravenswaaij-Arts et al. 1994, Patzal et al. 1996, Griffin et al. 1994
Power in low frequent domain	0,02-0,2 Hz: newborns, young infants; 0,02-0,05 Hz: older infants and children	LP*	Low frequent HRV (middle frequent HRV in newborns and young infants)	
Power in middle frequent domain	0,05-0,15 Hz: older infants and children	MF*	HRV in domain about 0,1 Hz, used only by older infants and children	
Power in high frequent domain	0,2-2,0 Hz: newborns, young infants; 0,15-1,0 Hz: older infants, children	HF*	High frequent, breathing correlated HRV, upper limit of 2,0 Hz by newborns and young infants arises from the high breathing frequency in this age group	

* These parameter designations can refer to analysis of heart period durations (Power unit: ms^2) or instantaneous heart rate (Unit: Hz^2).

Taken from: Patzak A, Mrowka R, Springer S, Eckardt T, Ipsiroglu OS, Erler T, Hofmann S, Gramse V-Projektgruppe Herzfrequenzvariabilität und AG Pädiatrie der Deutschen Gesellschaft für Schlafforschung und Schlafmedizin (2002): Empfehlungen für die Bestimmung der Herzfrequenzvariabilität im pädiatrischen Schlaflabor. Somnologie 6:39-50

Appendix 6.1.

Parental stress questionnaire (Vonderlin 1999)

Appendix 6.1

Name:____________________________________

Liebe Mutter,
die folgende Aussagen beschreiben Gedanken und Erlebnisse von Müttern Frühgeborener.
Geben Sie bitte für jede Aussage an, in welchem Maße diese für **Ihr eigenes Erleben** zutrifft.

A	**B**	**C**	**D**
trifft nicht zu	trifft wenig zu	trifft ziemlich zu	trifft sehr zu

1. Ich mache mir um die Zukunft meines Kindes viele Sorgen. A B C D
2. Der Gesundheitszustand meines Kindes ist kritisch. A B C D
3. Die hochentwickelte Technik auf der Station beruhigt mich. A B C D
4. Ich kann selbst dazu beitragen, dass es meinem Kind gut geht. A B C D
5. Ich habe oft das Gefühl, dass diese Situation über meine Kräfte geht. A B C D
6. Ich bin mir sicher, dass mein Kind gesund sein wird. A B C D
7. Ich bin mit der medizinischen Versorgung meines Kindes sehr zufrieden. A B C D
8. Ein Kind zu haben, hat mehr Probleme für meine Partnerschaft gebracht, als ich dachte. A B C D
9. Ich kann selbst dazu beitragen, dass sich mein Kind gut entwickelt. A B C D
10. Seit das Kind da ist, hat mein Partner mir nicht so viel Hilfe und Unterstützung gegeben, wie ich erwartete. A B C D
11. Ich habe schon Schlimmeres gemeistert. A B C D
12. Mein Kind wird immer mehr Liebe und Fürsorge brauchen. A B C D
13. Es ist ein Wunder, dass mein Kind lebt. A B C D
14. Ein Frühgeborenes ist eine größere Belastung als ein normales Baby. A B C D
15. Ich fühle mich den Ärzten hilflos ausgeliefert. A B C D
16. Ich habe große Angst, dass mein Kind sterben wird. A B C D
17. Mein Partner ist mir jetzt eine große Hilfe. A B C D
18. Mein Kind wird sich in allen Bereichen so entwickeln, wie normal geborene Kinder auch. A B C D
19. Die medizinischen Maßnahmen sind sehr besorgniserregend. A B C D
20. Ich kann mit meinem Partner offen über alle Problemen sprechen. A B C D
21. Die größeren Belastungen von Eltern Frühgeborener sind vorübergehend. A B C D
22. Ich werde in die Behandlung meines Kindes einbezogen. A B C D

Vonderlin, 1998

Name:____________________________________

Lieber Vater,
die folgende Aussagen beschreiben Gedanken und Erlebnisse von Vätern Frühgeborener.
Geben Sie bitte für jede Aussage an, in welchem Maße diese für **Ihr eigenes Erleben** zutrifft.

A	**B**	**C**	**D**
trifft nicht zu	trifft wenig zu	trifft ziemlich zu	trifft sehr zu

1. Ich mache mir um die Zukunft meines Kindes viele Sorgen. A B C D
2. Der Gesundheitszustand meines Kindes ist kritisch. A B C D
3. Ich werde in die Behandlung meines Kindes einbezogen. (22) A B C D
4. Ich kann selbst dazu beitragen, dass es meinem Kind gut geht. A B C D
5. Ich habe oft das Gefühl, dass diese Situation über meine Kräfte geht. A B C D
6. Ich bin mir sicher, dass mein Kind gesund sein wird. A B C D
7. Ich bin mit der medizinischen Versorgung meines Kindes sehr zufrieden. A B C D
8. Ein Kind zu haben, hat mehr Probleme für meine Partnerschaft gebracht, als ich dachte. A B C D
9. Seit mein letztes Kind da ist, habe ich weniger Interesse an Sex. A B C D
10. Ich kann selbst dazu beitragen, dass sich mein Kind gut entwickelt. A B C D
11. Seit das Kind da ist, hat meine Partnerin mir nicht so viel Hilfe und Unterstützung gegeben, wie ich erwartete. A B C D
12. Ich habe schon Schlimmeres gemeistert. A B C D
13. Mein Kind wird immer mehr Liebe und Fürsorge brauchen. A B C D
14. Es ist ein Wunder, dass mein Kind lebt. A B C D
15. Ein Frühgeborenes ist eine größere Belastung als ein normales Baby. A B C D
16. Ich fühle mich den Ärzten hilflos ausgeliefert. A B C D
17. Ich habe große Angst, dass mein Kind sterben wird. A B C D
18. Meine Partnerin ist mir jetzt eine große Hilfe. A B C D
19. Mein Kind wird sich in allen Bereichen so entwickeln, wie normal geborene Kinder auch. A B C D
20. Seit das Kind da ist, machen meine Partnerin und ich nicht mehr so viele Dinge zusammen. A B C D
21. Die medizinischen Maßnahmen sind sehr besorgniserregend. A B C D
22. Ich kann mit meinem Partner offen über alle Problemen sprechen. A B C D
23. Die größeren Belastungen von Eltern Frühgeborener sind vorübergehend. A B C D

Vonderlin, 1998

Appendix 6.2.

Parental competences questionnaire (Schneewind et al. 1989)

Appendix 6.2.

Was trifft für Sie im Moment zu?

Bitte machen Sie in jeder Zeile nur ein Kreuz, je nachdem, ob für Sie eher die Aussage auf der linken Seite oder die Aussage auf der rechten Seite zutrifft.

Die Routine im täglichen Umgang (z.B. beim Füttern, Baden, Wickeln) mit meinem Kind macht mir keine Schwierigkeiten.	**1**	**2**	**3**	**4**	**5**	**6**	Im täglichen Umgang mit meinem Baby stelle ich mich nicht sonderlich geschickt an.
Es gelingt mir leicht, mein Kind zu beruhigen, wenn es Schreit und sich unwohl fühlt.	**1**	**2**	**3**	**4**	**5**	**6**	Ich bin ziemlich hilflos, wenn mein Kind schreit und ich es beruhigen will.
Auch wenn mein Kind etwas macht, worauf ich mir keinen Reim machen kann, werde ich mit der Situation schon fertig.	**1**	**2**	**3**	**4**	**5**	**6**	Wenn mein Kind etwas macht, was ich nicht gleich durchschaue, bin ich ziemlich durcheinander.
Wenn ich meinem Baby beibringen will, dass es etwas nicht tun soll, dann finde ich auch die richtigen Mittel und Wege dazu.	**1**	**2**	**3**	**4**	**5**	**6**	Mir fehlt das Geschick, meinem Kind auf die richtige Art und Weise zu verstehen zu geben, dass es etwas nicht tun soll.
Ich bin fest davon überzeugt, dass ich alle die Fähigkeiten habe, um eine gute Mutter für mein Baby zu sein.	**1**	**2**	**3**	**4**	**5**	**6**	Alles in allem glaube ich, dass mir doch eine ganze Menge fehlt, um eine gute Mutter für mein Baby zu sein.
Ich weiß ziemlich genau, worauf ich achten muss, damit es meinem Säugling wirklich gut geht.	**1**	**2**	**3**	**4**	**5**	**6**	Ich weiß eigentlich nicht so recht, was ein Säugling wirklich braucht.
Wenn ich einen Säugling sehe, habe ich eine gutes Gespür dafür, wie es ihm gerade geht.	**1**	**2**	**3**	**4**	**5**	**6**	Mir fehlen einfach die Antennen, um zu spüren, wie es einem Säugling wirklich zumute ist.
Auch wenn sich bei meinem Kind mal die Probleme häufen, lasse ich mich nicht aus der Ruhe bringen.	**1**	**2**	**3**	**4**	**5**	**6**	Ich werde ziemlich schnell ungeduldig, wenn es mit meinem Kind mal nicht so läuft, wie ich mir das eigentlich vorstelle.

Vonderlin, 1998

Appendix 6.3.

Family Assessment Measure (Cierpka & Frevert 1994)

Appendix 6.3.

Name bzw.
Kenn-Nummer: ______________ Datum: __________

FB-Allgemeiner Familienbogen

Dieser Bogen wurde ausgefüllt von:

- ☐ Mutter/(Ehe)Partnerin
- ☐ Vater/(Ehe)Partner
- ☐ Tochter
- ☐ Sohn
- ☐ ____________________ Geburtsjahr: ____________

Anweisungen:

Auf den folgenden Seiten finden Sie 40 Aussagen über Ihre Familie. Bitte lesen Sie jede Aussage sorgfältig durch und entscheiden Sie, wie gut die Aussage Ihre Familie beschreibt. Bitte kreuzen Sie die für Sie am ehesten zutreffende Einschätzung in den **entsprechenden Kästchen** neben der Aussage an.

Bitte kreuzen Sie **nur ein** Kästchen (Einschätzung) für jede Aussage an. Beantworten Sie jede Aussage, selbst wenn Sie sich Ihrer Einschätzung nicht völlig sicher sind.

Tragen Sie bitte Ihre Stellung in der Familie und Ihr Geburtsjahr in die obigen Zeilen des Bogens ein.

Best.-Nr. 0113305

		stimmt genau	stimmt ein wenig	stimmt eher nicht	stimmt überhaupt nicht
1.	Wenn bei uns in der Familie Probleme aufkommen, suchen wir gemeinsam nach neuen Lösungswegen.	☐	☐	☐	☐
2.	Die Familienpflichten sind gerecht verteilt.	☐	☐	☐	☐
3.	Wenn ich jemanden in der Familie bitte, zu erklären, was er meint, bekomme ich offene und direkte Antworten.	☐	☐	☐	☐
4.	Wir teilen uns gegenseitig mit, wie es uns wirklich geht.	☐	☐	☐	☐
5.	Ich kann mir nicht vorstellen, daß irgendeine Familie besser klarkommt als unsere.	☐	☐	☐	☐
6.	In unserer Familie hat man es schwer, seinen eigenen Weg zu verfolgen.	☐	☐	☐	☐
7.	Wenn ich frage, warum wir bestimmte Regeln haben, bekomme ich keine befriedigende Antwort.	☐	☐	☐	☐
8.	Wir haben die gleichen Ansichten darüber, was richtig und falsch ist.	☐	☐	☐	☐
9.	Meine Familie könnte glücklicher sein, als sie tatsächlich ist.	☐	☐	☐	☐
10.	Manchmal sind wir ungerecht zueinander.	☐	☐	☐	☐
11.	Wir versuchen, Schwierigkeiten gleich zu lösen und nicht auf die lange Bank zu schieben.	☐	☐	☐	☐
12.	Wir stimmen darin überein, wer was in unserer Familie tun sollte.	☐	☐	☐	☐
13.	Ich weiß nie, was in unserer Familie los ist.	☐	☐	☐	☐
14.	In unserer Familie wissen wir gewöhnlich, wenn sich jemand aufgeregt hat.	☐	☐	☐	☐
15.	Ich glaube nicht, daß irgendeine Familie glücklicher als meine sein könnte.	☐	☐	☐	☐

		stimmt genau	stimmt ein wenig	stimmt eher nicht	stimmt überhaupt nicht
16.	Wir sind eng miteinander verbunden.	☐	☐	☐	☐
17.	Wenn man etwas falsch macht in unserer Familie, weiß man nicht, was man zu erwarten hat.	☐	☐	☐	☐
18.	In unserer Familie kann jeder seinen eigenen Interessen nachgehen, ohne daß die anderen deswegen sauer wären.	☐	☐	☐	☐
19.	Einige Dinge in unserer Familie stellen mich nicht vollständig zufrieden.	☐	☐	☐	☐
20.	Wir werden nie wütend in unserer Familie.	☐	☐	☐	☐
21.	Wir brauchen zu lange, um mit schwierigen Situationen zurechtzukommen.	☐	☐	☐	☐
22.	Wir können uns nicht darauf verlassen, daß alle Familienmitglieder die ihnen zugedachten Aufgaben erfüllen.	☐	☐	☐	☐
23.	Wir nehmen uns Zeit, einander anzuhören.	☐	☐	☐	☐
24.	Wenn wir uns in unserer Familie aufregen, brauchen wir zu lange, um darüber hinwegzukommen.	☐	☐	☐	☐
25.	Wir regen uns nie gegenseitig auf.	☐	☐	☐	☐
26.	Eigentlich vertrauen wir einander nicht.	☐	☐	☐	☐
27.	Wenn wir etwas falsch machen, bekommen wir keine Gelegenheit, es zu erklären.	☐	☐	☐	☐
28.	In unserer Familie haben wir die Freiheit, zu sagen, was wir denken.	☐	☐	☐	☐
29.	Meine Familie und ich verstehen einander vollkommen.	☐	☐	☐	☐
30.	Manchmal gehen wir uns gegenseitig aus dem Weg.	☐	☐	☐	☐

	stimmt genau	stimmt ein wenig	stimmt eher nicht	stimmt überhaupt nicht
31. Wir sind uns oft nicht einig, welche Probleme wir haben.	☐	☐	☐	☐
32. Wir müssen uns meistens gegenseitig daran erinnern, was in der Familie von den einzelnen getan werden muß.	☐	☐	☐	☐
33. Wir streiten in unserer Familie oft darüber, wer was gesagt hat.	☐	☐	☐	☐
34. Wir teilen einander mit, was uns gerade stört.	☐	☐	☐	☐
35. Manchmal verletzen wir die Gefühle der anderen.	☐	☐	☐	☐
36. In unserer Familie lebt jeder eher für sich.	☐	☐	☐	☐
37. In unserer Familie gibt es keine festen Regeln oder Vorschriften.	☐	☐	☐	☐
38. In unserer Familie haben wir die gleichen Vorstellungen über Erfolg und Leistung.	☐	☐	☐	☐
39. Wir sind so gut angepaßt, wie eine Familie nur sein kann.	☐	☐	☐	☐
40. Wir geben unsere Fehler immer zu und versuchen nicht, irgend etwas zu verbergen.	☐	☐	☐	☐

Appendix 8.1.

The information note about the study design and parental consent

Appendix 8.1.

Universitätsklinikum Heidelberg

Rechtsfähige Anstalt des öffentlichen Rechts der Universität Heidelberg

Universitätskinderklinik • Abt. IV • Im Neuenheimer Feld 150 • 69120 Heidelberg

Luisenheilanstalt

Universitätskinderklinik und Poliklinik

Abteilung Kinderheilkunde IV

- Schwerpunkt: Neonatologie –

Ärztlicher Direktor: Prof. Dr. O. Linderkamp

Im Neuenheimer Feld 150
D-69120 Heidelberg, den 20. August 2006

☎ (0 62 21) 56- 23 11 (Klinikpforte)
- 23 06

Fax (0 62 21) 56- 56 02

Otwin_Linderkamp@med.uni-heidelberg.de

Liebe Mutter,

zurzeit wird an der Abteilung Neonatologie der Kinderklinik in Zusammenarbeit mit der Psychosomatischen Klinik eine Studie durchgeführt, in welcher die Auswirkung der mütterlichen Stimme im Vergleich zur Musik bei frühgeborenen Babys (ca. 31-35 Schwangerschaftswoche) untersucht wird. Wir würden uns sehr freuen, wenn Sie an dieser Studie teilnehmen würden!

Die aktuelle Forschung beschäftigt sich mit der positiven Wirkung auditiver Stimulierung auf die Stressreduzierung, die frühe Sprachanbahnung und die Intelligenzentwicklung bei frühgeborenen Babys. Mit dieser Forschung soll herausgefunden werden, wie man frühgeborene Babys am besten fördern kann.

Die auditive Stimulierung in unserer Studie wird durch Musik oder die mütterliche Stimme stattfinden. Sie werden gebeten Ihrem Kind etwa fünfzehn Minuten lang ein Märchen vorzulesen, Ihre Stimme wird auf mit Tonband aufgenommen. Alternativ hört das Kind eine fünfzehnminütige Lullaby Melodie/Schlaflied. Die Stimulierung wird an zwei aufeinander folgenden Tagen wiederholt. Was Ihr Kind zuerst hört, wird zufällig entschieden. Die Wirkung der auditiven Stimulierung wird bei Ihrem Kind durch nicht-invasive Messungen von vitalen Parametern (Herzfrequenz und Herzfrequenzvariabilität sowie Atmung) 15 Minuten vor, während und 15 Minuten nach auditiven Stimulierung beobachtet. Die gesamte Untersuchung dauert 90 Minuten. Den Eltern werden Fragebögen (elterliches Stresserleben, Elternkompetenz, Allgemeiner Familienbogen) überreicht, die das momentan Stresserleben erfassen.

Sollten Sie Interesse haben, an dieser Studie teilzunehmen, bitte wir Sie um Ihre Unterschrift. Die erhobenen Daten werden im Fall Ihres Einverständnisses anonym behandelt. Die Teilnahme an der Studie ist freiwillig und Sie können Ihre Einwilligung ohne irgendeine Nachteile für Ihr Kind jederzeit widerrufen.

Ich, Frau ______________________________, die Mutter der/s kleinen ______________________________, nehme an der Studie teil.

Heidelberg, den ______________

Unterschrift

Universitätsklinikum Heidelberg

Rechtsfähige Anstalt des öffentlichen Rechts der Universität Heidelberg

Luisenheilanstalt

Universitätskinderklinik • Abt. IV • Im Neuenheimer Feld 150 • 69120 Heidelberg

Universitätskinderklinik und Poliklinik
Abteilung Kinderheilkunde IV
- Schwerpunkt: Neonatologie –
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☎ (0 62 21) 56- 23 11 (Klinikpforte)
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Otwin_Linderkamp@med.uni-heidelberg.de

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Ich, Herr ____, der Vater der/s kleinen ____________________________________, nehme an der Studie teil.

Heidelberg, den _______________

Unterschrift

Appendix 9.1.

VARIABLE COD USED FOR STATISTICAL ANALYSES:

First letter for the acoustic stimulation: C, L or M:

C – control situation without any acoustic stimulation, “placebo acoustic stimulation”
L – lullaby music as acoustic stimulation
M – fairytale reading as acoustic stimulation

Second letter for the time section: B, D and A:

B – before, 15 minutes before acoustic stimulation started
D – during, 15 minutes during the acoustic stimulation or placebo acoustic stimulation (C)
A – after, 15 minutes after the acoustic stimulation

Third letter for the behavioural state: N, R, W, S and T:

N – non-REM sleep
R – REM sleep
S – sleep
W – awake
T – total recording

Fourth and fifth letter for the heart rate variability measure:

MI – NN interval mean value
ME – NN interval median
VA – variance
SA – standard deviation
P6 – pnn 6,25
RM – RMSSD
SD – SDSD
RS – RSA

Here are the HRV measures (360 variables):

CBNMI
CBNME
CBNVA
CBNSA
CBNP6
CBNRM
CBNSD
CBNRS

CBRMI
CBRME
CBRVA
CBRSA
CBRP6
CBRRM
CBRSD
CBRRS

CBSMI
CBSME
CBSVA
CBSSA
CBSP6
CBSRM
CBSSD
CBSRS

CBWMI
CBWME
CBWVA
CBWSA
CBWP6
CBWRM
CBWSD
CBWRS

CBTMI
CBTME
CBTVA
CBTSA
CBTP6
CBTRM
CBTSD
CBTRS

CDNMI
CDNME
CDNVA
CDNSA
CDNP6
CDNRM
CDNSD
CDNRS

CDRMI
CDRME
CDRVA
CDRSA
CDRP6
CDRRM
CDRSD
CDRRS

CDSMI
CDSME
CDSVA
CDSSA
CDSP6
CDSRM
CDSSD
CDSRS

CDWMI
CDWME
CDWVA
CDWSA
CDWP6
CDWRM
CDWSD
CDWRS

CDTMI
CDTME
CDTVA
CDTSA
CDTP6
CDTRM
CDTSD
CDTRS

CANMI
CANME
CANVA
CANSA
CANP6
CANRM
CANSD
CANRS

CARMI
CARME
CARVA
CARSA
CARP6
CARRM
CARSD
CARRS

CASMI
CASME
CASVA
CASSA
CASP6
CASRM
CASSD
CASRS

CAWMI
CAWME
CAWVA
CAWSA
CAWP6
CAWRM
CAWSD
CAWRS

CATMI
CATME
CATVA
CATSA
CATP6
CATRM
CATSD
CATRS

LBNMI
LBNME
LBNVA
LBNSA
LBNP6
LBNRM
LBNSD
LBNRS

LBRMI
LBRME
LBRVA
LBRSA
LBRP6
LBRRM
LBRSD
LBRRS

LBSMI
LBSME
LBSVA
LBSSA
LBSP6
LBSRM
LBSSD
LBSRS

LBWMI
LBWME
LBWVA
LBWSA
LBWP6
LBWRM
LBWSD
LBWRS

LBTMI
LBTME
LBTVA
LBTSA
LBTP6
LBTRM
LBTSD
LBTRS

LDNMI
LDNME
LDNVA
LDNSA
LDNP6
LDNRM
LDNSD
LDNRS

LDRMI
LDRME
LDRVA
LDRSA
LDRP6
LDRRM
LDRSD
LDRRS

LDSMI
LDSME
LDSVA
LDSSA
LDSP6
LDSRM
LDSSD
LDSRS

LDWMI
LDWME
LDWVA
LDWSA
LDWP6
LDWRM
LDWSD
LDWRS

LDTMI
LDTME
LDTVA
LDTSA
LDTP6
LDTRM
LDTSD
LDTRS

LANMI
LANME
LANVA
LANSA
LANP6
LANRM
LANSD
LANRS

LARMI
LARME
LARVA
LARSA
LARP6
LARRM
LARSD
LARRS

LASMI
LASME
LASVA
LASSA
LASP6
LASRM
LASSD
LASRS

LAWMI
LAWME
LAWVA
LAWSA
LAWP6
LAWRM
LAWSD
LAWRS

LATMI
LATME
LATVA
LATSA
LATP6
LATRM
LATSD
LATRS

MBNMI	MDNMI	MANMI
MBNME	MDNME	MANME
MBNVA	MDNVA	MANVA
MBNSA	MDNSA	MANSA
MBNP6	MDNP6	MANP6
MBNRM	MDNRM	MANRM
MBNSD	MDNSD	MANSD
MBNRS	MDNRS	MANRS
MBRMI	MDRMI	MARMI
MBRME	MDRME	MARME
MBRVA	MDRVA	MARVA
MBRSA	MDRSA	MARSA
MBRP6	MDRP6	MARP6
MBRRM	MDRRM	MARRM
MBRSD	MDRSD	MARSD
MBRRS	MDRRS	MARRS
MBSMI	MDSMI	MASMI
MBSME	MDSME	MASME
MBSVA	MDSVA	MASVA
MBSSA	MDSSA	MASSA
MBSP6	MDSP6	MASP6
MBSRM	MDSRM	MASRM
MBSSD	MDSSD	MASSD
MBSRS	MDSRS	MASRS
MBWMI	MDWMI	MAWMI
MBWME	MDWME	MAWME
MBWVA	MDWVA	MAWVA
MBWSA	MDWSA	MAWSA
MBWP6	MDWP6	MAWP6
MBWRM	MDWRM	MAWRM
MBWSD	MDWSD	MAWSD
MBWRS	MDWRS	MAWRS
MBTMI	MDTMI	MATMI
MBTME	MDTME	MATME
MBTVA	MDTVA	MATVA
MBTSA	MDTSA	MATSA
MBTP6	MDTP6	MATP6
MBTRM	MDTRM	MATRM
MBTSD	MDTSD	MATSD
MBTRS	MDTRS	MATRS

Appendix 9.2.

Descripitive statistics and Boxplot Diagrams for different HRV measures – SPSS output (1-11)

Appendix 9.2.

Deskriptive Statistik und Boxplot-Diagramms für verschiedene HRV Maßen

Deskriptive Statistik für N-N Interval Mittelwert (MI)

Deskriptive Statistik

	N	Minimum	Maximum	Mittelwert	Standardabweichung
CBN2MI	20	379,40	458,25	416,4230	21,95941
CDN2MI	20	368,44	464,42	414,4375	21,32029
CAN2MI	20	362,44	463,87	408,0070	26,55244
LBN2MI	29	350,00	479,90	405,9610	34,58779
LDN2MI	29	351,21	467,06	409,2083	28,14884
LAN2MI	29	345,25	454,48	405,4476	30,57116
MBN2MI	30	346,52	460,96	413,0487	29,90913
MDN2MI	30	344,73	479,88	414,9060	32,15861
MAN2MI	30	363,98	459,06	415,2637	28,06209
Gültige Werte (Listenweise)	19				

Deskriptive Statistik für N-N Median (ME)

Deskriptive Statistik

	N	Minimum	Maximum	Mittelwert	Standardabweichung
CBN2ME	20	378,00	453,00	415,4500	21,62960
CDN2ME	20	369,00	463,00	413,2000	21,59337
CAN2ME	20	360,00	464,00	407,8500	28,52381
LBN2ME	29	350,00	464,00	404,5862	34,18491
LDN2ME	29	349,00	462,00	407,1034	28,75307
LAN2ME	29	357,00	452,00	404,1724	28,78996
MBN2ME	30	347,00	460,00	411,4667	29,36892
MDN2ME	30	345,00	488,00	414,0000	32,78562
MAN2ME	30	359,00	457,00	413,6667	28,61557
Gültige Werte (Listenweise)	19				

Deskriptive Statistik für N-N Interval Varianz (VA)

Deskriptive Statistik

	N	Minimum	Maximum	Mittelwert	Standardabweichung
CBN2VA	20	18,35	572,38	239,2800	196,32165
CDN2VA	20	25,81	1540,80	321,2290	428,40077
CAN2VA	20	46,68	1442,45	380,7640	379,72679
LBN2VA	29	9,59	3014,21	326,0555	578,88685
LDN2VA	29	23,04	2522,14	472,9700	596,34107
LAN2VA	29	31,04	1307,83	306,3145	317,26286
MBN2VA	30	11,80	783,98	270,3703	235,53405
MDN2VA	30	11,22	2207,60	279,9917	407,39991
MAN2VA	30	15,03	2667,43	386,2120	527,75389
Gültige Werte (Listenweise)	19				

Deskriptive Statistik für N-N Interval Standard Abweichung (SA)

Deskriptive Statistik

	N	Minimum	Maximum	Mittelwert	Standardabweichung
CBN2SA	20	4,28	23,92	13,9665	6,82124
CDN2SA	20	5,08	39,25	14,9290	10,17392
CAN2SA	20	6,83	37,98	17,4015	9,05518
LBN2SA	29	3,10	54,90	14,5724	10,85146
LDN2SA	29	4,80	50,22	18,3479	11,88262
LAN2SA	29	5,57	36,16	15,7138	7,85371
MBN2SA	30	4,59	28,00	15,0257	7,04215
MDN2SA	30	3,35	46,99	14,2613	8,90351
MAN2SA	30	3,88	51,65	16,8700	10,25357
Gültige Werte (Listenweise)	19				

Deskriptive Statistik für pnn6,25% (P6)

Deskriptive Statistik

	N	Minimum	Maximum	Mittelwert	Standardabweichung
CBN2P6	20	,00	13,33	1,4920	3,20915
CDN2P6	20	,00	5,83	,9025	1,73361
CAN2P6	20	,00	8,33	1,0845	2,07693
LBN2P6	29	,00	24,17	2,7438	5,58961
LDN2P6	29	,00	24,17	4,1514	6,10751
LAN2P6	29	,00	20,83	2,5693	4,48980
MBN2P6	30	,00	27,83	2,6650	5,91737
MDN2P6	30	,00	25,00	2,6563	6,29984
MAN2P6	30	,00	54,17	3,7893	10,64271
Gültige Werte (Listenweise)	19				

Deskriptive Statistik für RMSSD (RM)

Deskriptive Statistik

	N	Minimum	Maximum	Mittelwert	Standardabweichung
CBN2RM	20	2,03	12,20	5,1700	3,12266
CDN2RM	20	1,66	11,53	5,1240	2,92182
CAN2RM	20	1,42	11,03	5,2015	2,75208
LBN2RM	29	1,76	16,89	6,1352	4,41870
LDN2RM	29	1,48	15,97	7,1393	4,20239
LAN2RM	29	1,70	15,52	6,0276	3,31250
MBN2RM	30	1,48	22,27	6,2990	4,63832
MDN2RM	30	1,93	19,90	6,0713	4,38290
MAN2RM	30	1,30	34,95	6,7503	6,32509
Gültige Werte (Listenweise)	19				

Deskriptive Statistik für SDSD (SD)

Deskriptive Statistik

	N	Minimum	Maximum	Mittelwert	Standardabweichung
CBN2SD	20	1,60	12,73	4,6200	2,99999
CDN2SD	20	1,45	23,77	5,9370	5,39273
CAN2SD	20	2,12	10,70	5,1855	2,63461
LBN2SD	29	1,32	17,62	5,7441	4,23691
LDN2SD	29	1,37	21,07	7,5017	5,50740
LAN2SD	29	1,51	16,41	6,0690	3,46201
MBN2SD	30	1,21	30,74	6,6230	6,50693
MDN2SD	30	1,49	19,84	5,3000	4,12255
MAN2SD	30	1,11	45,10	7,3650	8,66749
Gültige Werte (Listenweise)	19				

Deskriptive Statistik für RSA (RS)

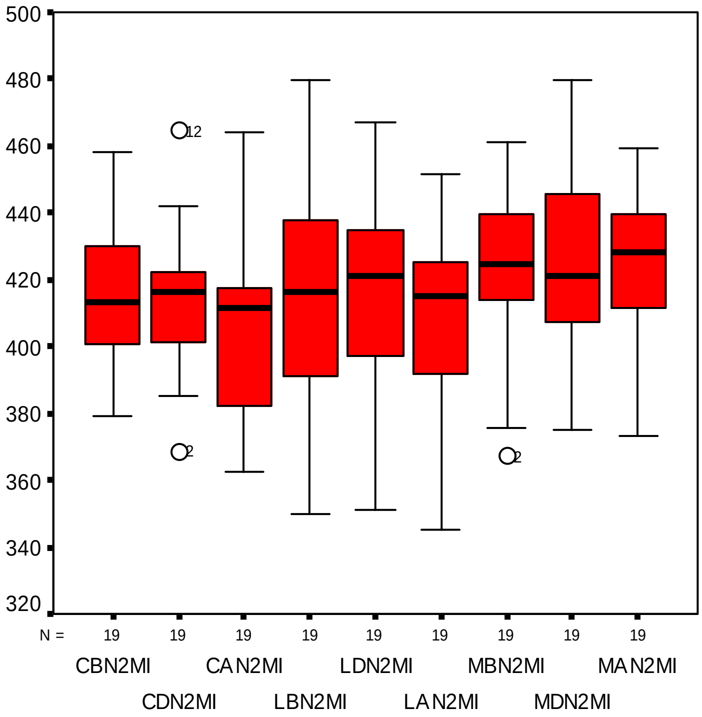
Deskriptive Statistik

	N	Minimum	Maximum	Mittelwert	Standardabweichung
CBN2RS	20	,99	10,10	4,3045	2,67237
CDN2RS	20	,86	18,15	5,5130	5,24046
CAN2RS	20	1,48	18,33	6,0755	4,44698
LBN2RS	29	,77	19,48	4,7848	4,30699
LDN2RS	29	,88	18,56	6,0421	5,13324
LAN2RS	29	,77	15,21	4,8386	3,22075
MBN2RS	30	,86	14,26	4,7463	3,21863
MDN2RS	30	,41	27,37	5,1277	5,16426
MAN2RS	30	,54	47,59	6,0753	8,21710
Gültige Werte (Listenweise)	19				

Explorative Datenanalyse und Boxplot-Diagramm für N-N Interval Mittelwert (MI)

Verarbeitete Fälle

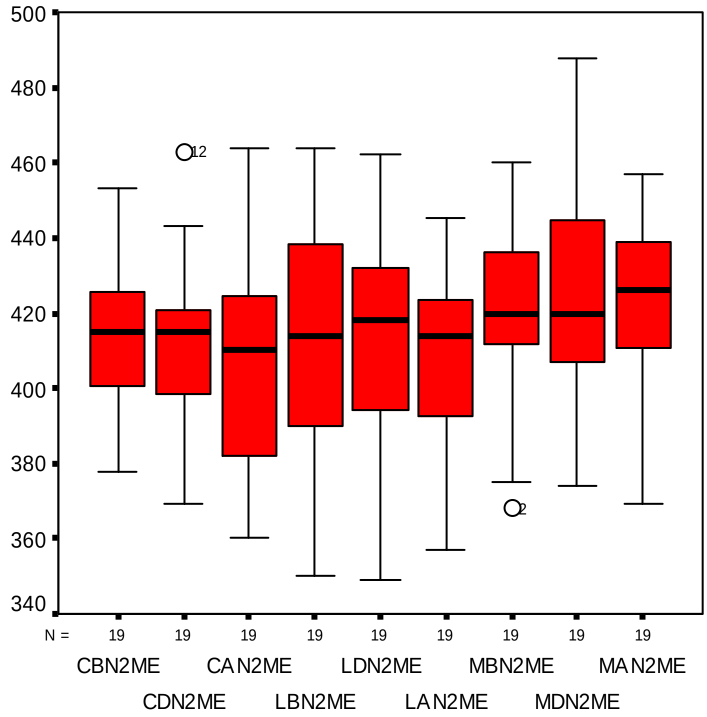
	Fälle					
	Gültig		Fehlend		Gesamt	
	N	Prozent	N	Prozent	N	Prozent
CBN2MI	19	63,3%	11	36,7%	30	100,0%
CDN2MI	19	63,3%	11	36,7%	30	100,0%
CAN2MI	19	63,3%	11	36,7%	30	100,0%
LBN2MI	19	63,3%	11	36,7%	30	100,0%
LDN2MI	19	63,3%	11	36,7%	30	100,0%
LAN2MI	19	63,3%	11	36,7%	30	100,0%
MBN2MI	19	63,3%	11	36,7%	30	100,0%
MDN2MI	19	63,3%	11	36,7%	30	100,0%
MAN2MI	19	63,3%	11	36,7%	30	100,0%



Explorative Datenanalyse und Boxplot-Diagramm für N-N Interval Median (ME)

Verarbeitete Fälle

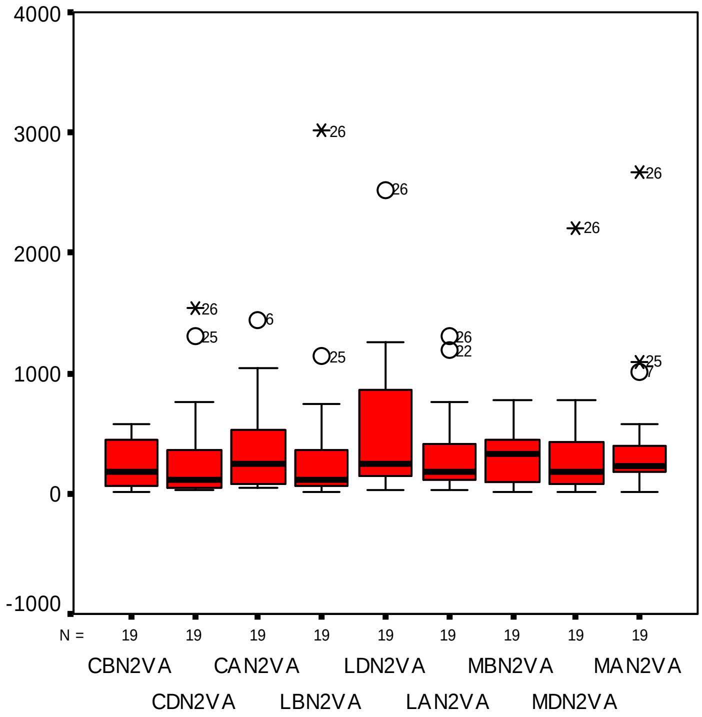
	Fälle					
	Gültig		Fehlend		Gesamt	
	N	Prozent	N	Prozent	N	Prozent
CBN2ME	19	63,3%	11	36,7%	30	100,0%
CDN2ME	19	63,3%	11	36,7%	30	100,0%
CAN2ME	19	63,3%	11	36,7%	30	100,0%
LBN2ME	19	63,3%	11	36,7%	30	100,0%
LDN2ME	19	63,3%	11	36,7%	30	100,0%
LAN2ME	19	63,3%	11	36,7%	30	100,0%
MBN2ME	19	63,3%	11	36,7%	30	100,0%
MDN2ME	19	63,3%	11	36,7%	30	100,0%
MAN2ME	19	63,3%	11	36,7%	30	100,0%



Explorative Datenanalyse und Boxplot-Diagramm für N-N Interval Varianz (VA)

Verarbeitete Fälle

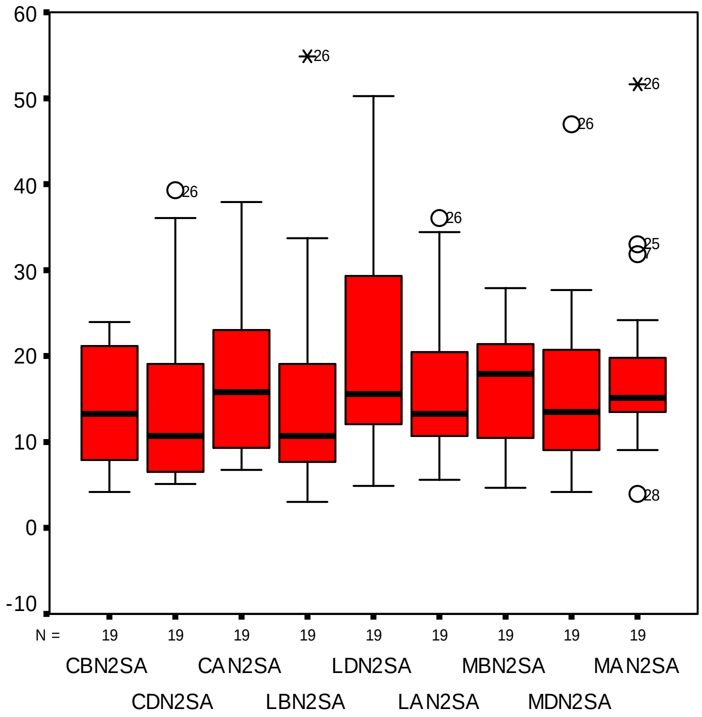
	Fälle					
	Gültig		Fehlend		Gesamt	
	N	Prozent	N	Prozent	N	Prozent
CBN2VA	19	63,3%	11	36,7%	30	100,0%
CDN2VA	19	63,3%	11	36,7%	30	100,0%
CAN2VA	19	63,3%	11	36,7%	30	100,0%
LBN2VA	19	63,3%	11	36,7%	30	100,0%
LDN2VA	19	63,3%	11	36,7%	30	100,0%
LAN2VA	19	63,3%	11	36,7%	30	100,0%
MBN2VA	19	63,3%	11	36,7%	30	100,0%
MDN2VA	19	63,3%	11	36,7%	30	100,0%
MAN2VA	19	63,3%	11	36,7%	30	100,0%



Explorative Datenanalyse und Boxplot-Diagramm für N-N Interval Standard Abweichung (SA)

Verarbeitete Fälle

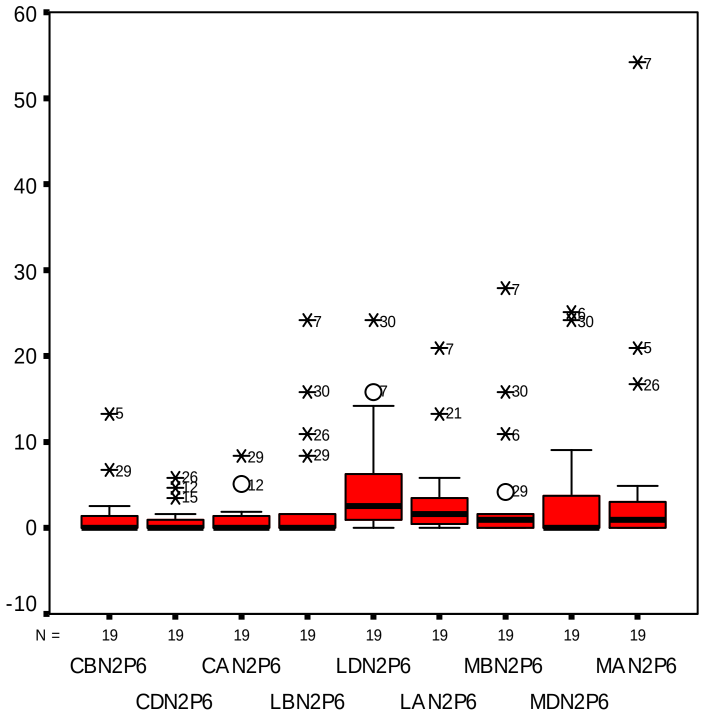
	Fälle					
	Gültig		Fehlend		Gesamt	
	N	Prozent	N	Prozent	N	Prozent
CBN2SA	19	63,3%	11	36,7%	30	100,0%
CDN2SA	19	63,3%	11	36,7%	30	100,0%
CAN2SA	19	63,3%	11	36,7%	30	100,0%
LBN2SA	19	63,3%	11	36,7%	30	100,0%
LDN2SA	19	63,3%	11	36,7%	30	100,0%
LAN2SA	19	63,3%	11	36,7%	30	100,0%
MBN2SA	19	63,3%	11	36,7%	30	100,0%
MDN2SA	19	63,3%	11	36,7%	30	100,0%
MAN2SA	19	63,3%	11	36,7%	30	100,0%



Explorative Datenanalyse und Boxplot-Diagramm für pnn 6,25% (P6)

Verarbeitete Fälle

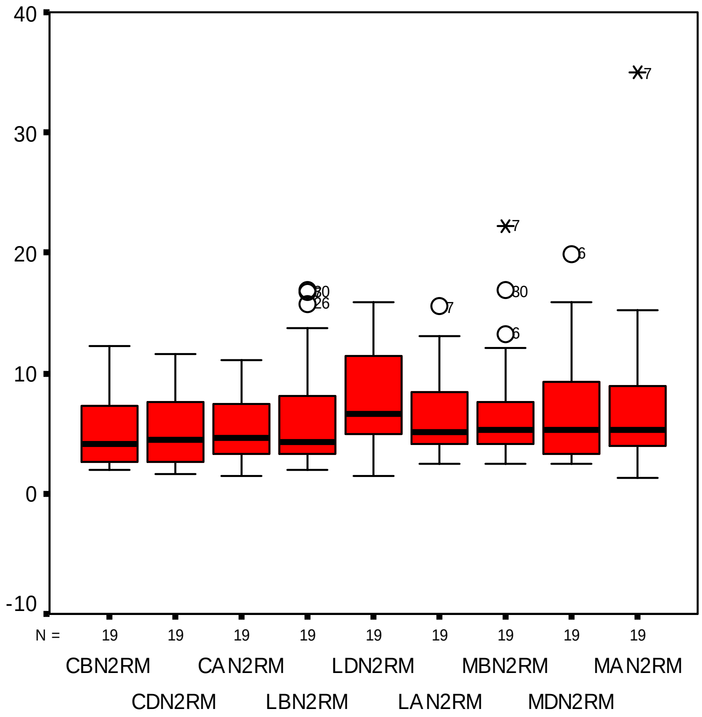
	Fälle					
	Gültig		Fehlend		Gesamt	
	N	Prozent	N	Prozent	N	Prozent
CBN2P6	19	63,3%	11	36,7%	30	100,0%
CDN2P6	19	63,3%	11	36,7%	30	100,0%
CAN2P6	19	63,3%	11	36,7%	30	100,0%
LBN2P6	19	63,3%	11	36,7%	30	100,0%
LDN2P6	19	63,3%	11	36,7%	30	100,0%
LAN2P6	19	63,3%	11	36,7%	30	100,0%
MBN2P6	19	63,3%	11	36,7%	30	100,0%
MDN2P6	19	63,3%	11	36,7%	30	100,0%
MAN2P6	19	63,3%	11	36,7%	30	100,0%



Explorative Datenanalyse und Boxplot-Diagramm für RMSSD (RM)

Verarbeitete Fälle

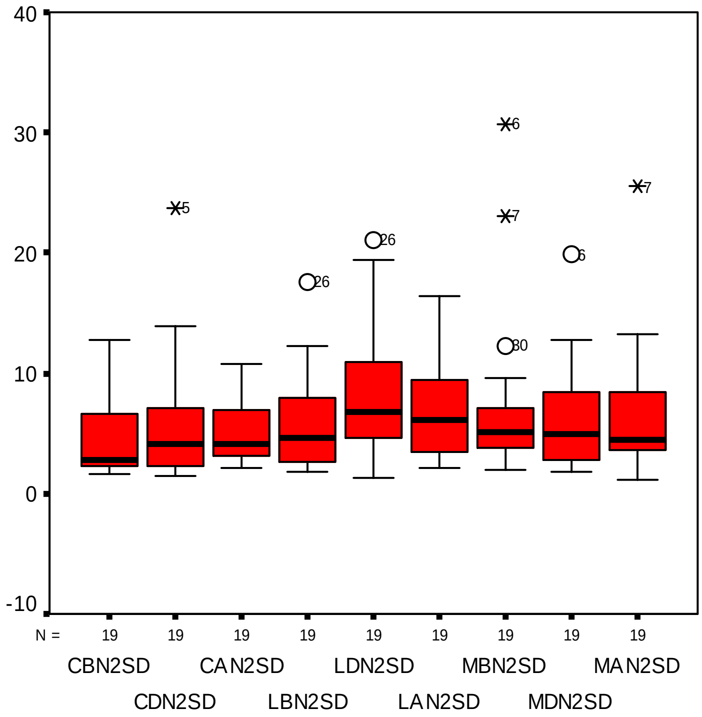
	Fälle					
	Gültig		Fehlend		Gesamt	
	N	Prozent	N	Prozent	N	Prozent
CBN2RM	19	63,3%	11	36,7%	30	100,0%
CDN2RM	19	63,3%	11	36,7%	30	100,0%
CAN2RM	19	63,3%	11	36,7%	30	100,0%
LBN2RM	19	63,3%	11	36,7%	30	100,0%
LDN2RM	19	63,3%	11	36,7%	30	100,0%
LAN2RM	19	63,3%	11	36,7%	30	100,0%
MBN2RM	19	63,3%	11	36,7%	30	100,0%
MDN2RM	19	63,3%	11	36,7%	30	100,0%
MAN2RM	19	63,3%	11	36,7%	30	100,0%



Explorative Datenanalyse und Boxplot-Diagramm für SDSD (SD)

Verarbeitete Fälle

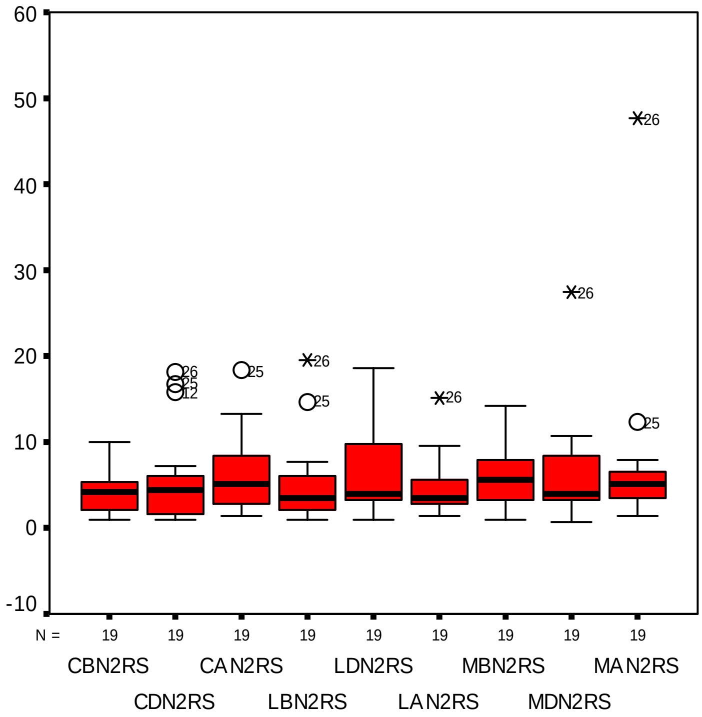
	Fälle					
	Gültig		Fehlend		Gesamt	
	N	Prozent	N	Prozent	N	Prozent
CBN2SD	19	63,3%	11	36,7%	30	100,0%
CDN2SD	19	63,3%	11	36,7%	30	100,0%
CAN2SD	19	63,3%	11	36,7%	30	100,0%
LBN2SD	19	63,3%	11	36,7%	30	100,0%
LDN2SD	19	63,3%	11	36,7%	30	100,0%
LAN2SD	19	63,3%	11	36,7%	30	100,0%
MBN2SD	19	63,3%	11	36,7%	30	100,0%
MDN2SD	19	63,3%	11	36,7%	30	100,0%
MAN2SD	19	63,3%	11	36,7%	30	100,0%



Explorative Datenanalyse und Boxplot-Diagramm für RSA (RS)

Verarbeitete Fälle

	Fälle					
	Gültig		Fehlend		Gesamt	
	N	Prozent	N	Prozent	N	Prozent
CBN2RS	19	63,3%	11	36,7%	30	100,0%
CDN2RS	19	63,3%	11	36,7%	30	100,0%
CAN2RS	19	63,3%	11	36,7%	30	100,0%
LBN2RS	19	63,3%	11	36,7%	30	100,0%
LDN2RS	19	63,3%	11	36,7%	30	100,0%
LAN2RS	19	63,3%	11	36,7%	30	100,0%
MBN2RS	19	63,3%	11	36,7%	30	100,0%
MDN2RS	19	63,3%	11	36,7%	30	100,0%
MAN2RS	19	63,3%	11	36,7%	30	100,0%


60
50
40
30
20
10
0
-10
N = 19 19 19 19 19 19 19 19 19
CBN2RS CAN2RS LDN2RS MBN2RS MAN2RS
CDN2RS LBN2RS LAN2RS MDN2RS

Two-way ANOVA repeated measures
for factor "acoustic stimulation",
factor "time" and
the interaction between the acoustic stimulation and time
– SPSS output (1-41)

Appendix 9.3.

Allgemeines Lineares Modell - ANOVA Meßwertwiederholungen (Two-way repeated measures ANOVA): Innersubjektfaktor1 (Within Subject Factor 1) = AKUSTIM (akustische Stimulation), Innersubjektfaktor2 (Within Subject Factor 2) = ZEIT, sowie Interaktion zwischen Faktor 1 und 2

Allgemeines Lineares Modell - ANOVA Meßwertwiederholungen für N-N Interval Median (ME)

Innersubjektfaktoren

Maß: MASS_1

AKUSTIM	ZEIT	Abhängige Variable
1	1	CBN2ME
	2	CDN2ME
	3	CAN2ME
2	1	LBN2ME
	2	LDN2ME
	3	LAN2ME
3	1	MBN2ME
	2	MDN2ME
	3	MAN2ME

Deskriptive Statistiken

	Mittelwert	Standardabweichung	N
CBN2ME	414,4211	21,71358	19
CDN2ME	412,4211	21,89448	19
CAN2ME	406,2105	28,32074	19
LBN2ME	412,0000	35,38989	19
LDN2ME	412,4737	29,21828	19
LAN2ME	407,5263	28,09581	19
MBN2ME	419,8947	26,44049	19
MDN2ME	423,6842	29,07090	19
MAN2ME	420,8421	25,36678	19

Multivariate Tests[b]

Effekt		Wert	F	Hypothese df	Fehler df
AKUSTIM	Pillai-Spur	,395	5,549[a]	2,000	17,000
	Wilks-Lambda	,605	5,549[a]	2,000	17,000
	Hotelling-Spur	,653	5,549[a]	2,000	17,000
	Größte charakteristische Wurzel nach Roy	,653	5,549[a]	2,000	17,000
ZEIT	Pillai-Spur	,323	4,051[a]	2,000	17,000
	Wilks-Lambda	,677	4,051[a]	2,000	17,000
	Hotelling-Spur	,477	4,051[a]	2,000	17,000
	Größte charakteristische Wurzel nach Roy	,477	4,051[a]	2,000	17,000
AKUSTIM * ZEIT	Pillai-Spur	,066	,265[a]	4,000	15,000
	Wilks-Lambda	,934	,265[a]	4,000	15,000
	Hotelling-Spur	,071	,265[a]	4,000	15,000
	Größte charakteristische Wurzel nach Roy	,071	,265[a]	4,000	15,000

Multivariate Tests[b]

Effekt		Signifikanz	Partielles Eta-Quadrat
AKUSTIM	Pillai-Spur	,014	,395
	Wilks-Lambda	,014	,395
	Hotelling-Spur	,014	,395
	Größte charakteristische Wurzel nach Roy	,014	,395
ZEIT	Pillai-Spur	,036	,323
	Wilks-Lambda	,036	,323
	Hotelling-Spur	,036	,323
	Größte charakteristische Wurzel nach Roy	,036	,323
AKUSTIM * ZEIT	Pillai-Spur	,896	,066
	Wilks-Lambda	,896	,066
	Hotelling-Spur	,896	,066
	Größte charakteristische Wurzel nach Roy	,896	,066

a. Exakte Statistik

b.
Design: Intercept
Innersubjekt-Design: AKUSTIM+ZEIT+AKUSTIM*ZEIT

Mauchly-Test auf Sphärizität[b]

Maß: MASS_1

Innersubjekteffekt	Mauchly-W	Approximiertes Chi-Quadrat	df	Signifikanz
AKUSTIM	,664	6,958	2	,031
ZEIT	,539	10,492	2	,005
AKUSTIM * ZEIT	,389	15,502	9	,079

Prüft die Nullhypothese, daß sich die Fehlerkovarianz-Matrix der orthonormalisierten transformierten abhängigen Variablen proportional zur Einheitsmatrix verhält.

Mauchly-Test auf Sphärizität[b]

Maß: MASS_1

Innersubjekteffekt	Epsilon[a]		
	Greenhouse-Geisser	Huynh-Feldt	Untergrenze
AKUSTIM	,749	,801	,500
ZEIT	,685	,722	,500
AKUSTIM * ZEIT	,715	,865	,250

Prüft die Nullhypothese, daß sich die Fehlerkovarianz-Matrix der orthonormalisierten transformierten abhängigen Variablen proportional zur Einheitsmatrix verhält.

a. Kann zum Korrigieren der Freiheitsgrade für die gemittelten Signifikanztests verwendet werden. In der Tabelle mit den Tests der Effekte innerhalb der Subjekte werden korrigierte Tests angezeigt.

b.
Design: Intercept
Innersubjekt-Design: AKUSTIM+ZEIT+AKUSTIM*ZEIT

Tests der Innersubjekteffekte

Maß: MASS_1

Quelle		Quadratsumme vom Typ III	df	Mittel der Quadrate	F
AKUSTIM	Sphärizität angenommen	4298,667	2	2149,333	2,471
	Greenhouse-Geisser	4298,667	1,497	2871,294	2,471
	Huynh-Feldt	4298,667	1,602	2682,538	2,471
	Untergrenze	4298,667	1,000	4298,667	2,471
Fehler(AKUSTIM)	Sphärizität angenommen	31309,556	36	869,710	
	Greenhouse-Geisser	31309,556	26,948	1161,845	
	Huynh-Feldt	31309,556	28,844	1085,467	
	Untergrenze	31309,556	18,000	1739,420	
ZEIT	Sphärizität angenommen	715,404	2	357,702	1,696
	Greenhouse-Geisser	715,404	1,369	522,438	1,696
	Huynh-Feldt	715,404	1,444	495,367	1,696
	Untergrenze	715,404	1,000	715,404	1,696
Fehler(ZEIT)	Sphärizität angenommen	7592,152	36	210,893	
	Greenhouse-Geisser	7592,152	24,648	308,018	
	Huynh-Feldt	7592,152	25,995	292,058	
	Untergrenze	7592,152	18,000	421,786	
AKUSTIM * ZEIT	Sphärizität angenommen	412,140	4	103,035	,591
	Greenhouse-Geisser	412,140	2,861	144,036	,591
	Huynh-Feldt	412,140	3,459	119,147	,591
	Untergrenze	412,140	1,000	412,140	,591
Fehler(AKUSTIM* ZEIT)	Sphärizität angenommen	12550,304	72	174,310	
	Greenhouse-Geisser	12550,304	51,505	243,674	
	Huynh-Feldt	12550,304	62,264	201,567	
	Untergrenze	12550,304	18,000	697,239	

Tests der Innersubjekteffekte

Maß: MASS_1

Quelle		Signifikanz	Partielles Eta-Quadrat
AKUSTIM	Sphärizität angenommen	,099	,121
	Greenhouse-Geisser	,116	,121
	Huynh-Feldt	,112	,121
	Untergrenze	,133	,121
Fehler(AKUSTIM)	Sphärizität angenommen		
	Greenhouse-Geisser		
	Huynh-Feldt		
	Untergrenze		
ZEIT	Sphärizität angenommen	,198	,086
	Greenhouse-Geisser	,207	,086
	Huynh-Feldt	,206	,086
	Untergrenze	,209	,086
Fehler(ZEIT)	Sphärizität angenommen		
	Greenhouse-Geisser		
	Huynh-Feldt		
	Untergrenze		
AKUSTIM * ZEIT	Sphärizität angenommen	,670	,032
	Greenhouse-Geisser	,616	,032
	Huynh-Feldt	,647	,032
	Untergrenze	,452	,032
Fehler(AKUSTIM* ZEIT)	Sphärizität angenommen		
	Greenhouse-Geisser		
	Huynh-Feldt		
	Untergrenze		

Tests der Innersubjektkontraste

Maß: MASS_1

Quelle	AKUSTIM	ZEIT	Quadratsumme vom Typ III	df	Mittel der Quadrate	F
AKUSTIM	Linear		3115,930	1	3115,930	5,015
	Quadratisch		1182,737	1	1182,737	1,058
Fehler(AKUSTIM)	Linear		11182,737	18	621,263	
	Quadratisch		20126,819	18	1118,157	
ZEIT		Linear	436,219	1	436,219	1,399
		Quadratisch	279,184	1	279,184	2,539
Fehler(ZEIT)		Linear	5612,947	18	311,830	
		Quadratisch	1979,205	18	109,956	
AKUSTIM * ZEIT	Linear	Linear	398,368	1	398,368	1,211
		Quadratisch	9,281	1	9,281	,067
	Quadratisch	Linear	4,491	1	4,491	,025
		Quadratisch	4,657E-10	1	4,657E-10	,000
Fehler(AKUSTIM* ZEIT)	Linear	Linear	5920,632	18	328,924	
		Quadratisch	2509,053	18	139,392	
	Quadratisch	Linear	3240,842	18	180,047	
		Quadratisch	879,778	18	48,877	

Tests der Innersubjektkontraste

Maß: MASS_1

Quelle	AKUSTIM	ZEIT	Signifikanz	Partielles Eta-Quadrat
AKUSTIM	Linear		,038	,218
	Quadratisch		,317	,056
Fehler(AKUSTIM)	Linear			
	Quadratisch			
ZEIT		Linear	,252	,072
		Quadratisch	,128	,124
Fehler(ZEIT)		Linear		
		Quadratisch		
AKUSTIM * ZEIT	Linear	Linear	,286	,063
		Quadratisch	,799	,004
	Quadratisch	Linear	,876	,001
		Quadratisch	1,000	,000
Fehler(AKUSTIM* ZEIT)	Linear	Linear		
		Quadratisch		
	Quadratisch	Linear		
		Quadratisch		

Tests der Zwischensubjekteffekte

Maß: MASS_1
Transformierte Variable: Mittel

Quelle	Quadratsumme vom Typ III	df	Mittel der Quadrate	F	Signifikanz	Partielles Eta-Quadrat
Intercept	29363389,474	1	29363389	7382,033	,000	,998
Fehler	71598,304	18	3977,684			

Allgemeines Lineares Modell - ANOVA Meßwertwiederholungen für N-N Interval Mittelwert (MI)

Innersubjektfaktoren

Maß: MASS_1

AKUSTIM	ZEIT	Abhängige Variable
1	1	CBN2MI
	2	CDN2MI
	3	CAN2MI
2	1	LBN2MI
	2	LDN2MI
	3	LAN2MI
3	1	MBN2MI
	2	MDN2MI
	3	MAN2MI

Deskriptive Statistiken

	Mittelwert	Standardabweichung	N
CBN2MI	415,5379	22,19159	19
CDN2MI	413,8526	21,73905	19
CAN2MI	406,5737	26,47319	19
LBN2MI	413,4732	36,48934	19
LDN2MI	414,6168	27,88388	19
LAN2MI	408,5621	30,33110	19
MBN2MI	422,0179	26,96701	19
MDN2MI	424,5879	27,66506	19
MAN2MI	422,5637	24,90297	19

Multivariate Tests[b]

Effekt		Wert	F	Hypothese df	Fehler df
AKUSTIM	Pillai-Spur	,413	5,992[a]	2,000	17,000
	Wilks-Lambda	,587	5,992[a]	2,000	17,000
	Hotelling-Spur	,705	5,992[a]	2,000	17,000
	Größte charakteristische Wurzel nach Roy	,705	5,992[a]	2,000	17,000
ZEIT	Pillai-Spur	,426	6,300[a]	2,000	17,000
	Wilks-Lambda	,574	6,300[a]	2,000	17,000
	Hotelling-Spur	,741	6,300[a]	2,000	17,000
	Größte charakteristische Wurzel nach Roy	,741	6,300[a]	2,000	17,000
AKUSTIM * ZEIT	Pillai-Spur	,092	,379[a]	4,000	15,000
	Wilks-Lambda	,908	,379[a]	4,000	15,000
	Hotelling-Spur	,101	,379[a]	4,000	15,000
	Größte charakteristische Wurzel nach Roy	,101	,379[a]	4,000	15,000

Multivariate Tests[b]

Effekt		Signifikanz	Partielles Eta-Quadrat
AKUSTIM	Pillai-Spur	,011	,413
	Wilks-Lambda	,011	,413
	Hotelling-Spur	,011	,413
	Größte charakteristische Wurzel nach Roy	,011	,413
ZEIT	Pillai-Spur	,009	,426
	Wilks-Lambda	,009	,426
	Hotelling-Spur	,009	,426
	Größte charakteristische Wurzel nach Roy	,009	,426
AKUSTIM * ZEIT	Pillai-Spur	,820	,092
	Wilks-Lambda	,820	,092
	Hotelling-Spur	,820	,092
	Größte charakteristische Wurzel nach Roy	,820	,092

a. Exakte Statistik

b.
Design: Intercept
Innersubjekt-Design: AKUSTIM+ZEIT+AKUSTIM*ZEIT

Mauchly-Test auf Sphärizität[b]

Maß: MASS_1

Innersubjekteffekt	Mauchly-W	Approximiertes Chi-Quadrat	df	Signifikanz
AKUSTIM	,672	6,746	2	,034
ZEIT	,441	13,901	2	,001
AKUSTIM * ZEIT	,535	10,258	9	,332

Prüft die Nullhypothese, daß sich die Fehlerkovarianz-Matrix der orthonormalisierten transformierten abhängigen Variablen proportional zur Einheitsmatrix verhält.

Mauchly-Test auf Sphärizität[b]

Maß: MASS_1

Innersubjekteffekt	Epsilon[a]		
	Greenhouse-Geisser	Huynh-Feldt	Untergrenze
AKUSTIM	,753	,807	,500
ZEIT	,642	,669	,500
AKUSTIM * ZEIT	,766	,940	,250

Prüft die Nullhypothese, daß sich die Fehlerkovarianz-Matrix der orthonormalisierten transformierten abhängigen Variablen proportional zur Einheitsmatrix verhält.

a. Kann zum Korrigieren der Freiheitsgrade für die gemittelten Signifikanztests verwendet werden. In der Tabelle mit den Tests der Effekte innerhalb der Subjekte werden korrigierte Tests angezeigt.

b.
Design: Intercept
Innersubjekt-Design: AKUSTIM+ZEIT+AKUSTIM*ZEIT

Tests der Innersubjekteffekte

Maß: MASS_1

Quelle		Quadratsumme vom Typ III	df	Mittel der Quadrate	F
AKUSTIM	Sphärizität angenommen	4560,933	2	2280,467	2,720
	Greenhouse-Geisser	4560,933	1,507	3027,472	2,720
	Huynh-Feldt	4560,933	1,614	2825,506	2,720
	Untergrenze	4560,933	1,000	4560,933	2,720
Fehler(AKUSTIM)	Sphärizität angenommen	30183,227	36	838,423	
	Greenhouse-Geisser	30183,227	27,117	1113,063	
	Huynh-Feldt	30183,227	29,056	1038,809	
	Untergrenze	30183,227	18,000	1676,846	
ZEIT	Sphärizität angenommen	881,715	2	440,857	2,269
	Greenhouse-Geisser	881,715	1,283	687,101	2,269
	Huynh-Feldt	881,715	1,339	658,553	2,269
	Untergrenze	881,715	1,000	881,715	2,269
Fehler(ZEIT)	Sphärizität angenommen	6994,035	36	194,279	
	Greenhouse-Geisser	6994,035	23,098	302,795	
	Huynh-Feldt	6994,035	24,100	290,214	
	Untergrenze	6994,035	18,000	388,558	
AKUSTIM * ZEIT	Sphärizität angenommen	443,642	4	110,910	,691
	Greenhouse-Geisser	443,642	3,063	144,855	,691
	Huynh-Feldt	443,642	3,762	117,935	,691
	Untergrenze	443,642	1,000	443,642	,691
Fehler(AKUSTIM*ZEIT)	Sphärizität angenommen	11557,723	72	160,524	
	Greenhouse-Geisser	11557,723	55,128	209,653	
	Huynh-Feldt	11557,723	67,712	170,690	
	Untergrenze	11557,723	18,000	642,096	

Tests der Innersubjekteffekte

Maß: MASS_1

Quelle		Signifikanz	Partielles Eta-Quadrat
AKUSTIM	Sphärizität angenommen	,079	,131
	Greenhouse-Geisser	,096	,131
	Huynh-Feldt	,092	,131
	Untergrenze	,116	,131
Fehler(AKUSTIM)	Sphärizität angenommen		
	Greenhouse-Geisser		
	Huynh-Feldt		
	Untergrenze		
ZEIT	Sphärizität angenommen	,118	,112
	Greenhouse-Geisser	,141	,112
	Huynh-Feldt	,139	,112
	Untergrenze	,149	,112
Fehler(ZEIT)	Sphärizität angenommen		
	Greenhouse-Geisser		
	Huynh-Feldt		
	Untergrenze		
AKUSTIM * ZEIT	Sphärizität angenommen	,601	,037
	Greenhouse-Geisser	,564	,037
	Huynh-Feldt	,592	,037
	Untergrenze	,417	,037
Fehler(AKUSTIM* ZEIT)	Sphärizität angenommen		
	Greenhouse-Geisser		
	Huynh-Feldt		
	Untergrenze		

Tests der Innersubjektkontraste

Maß: MASS_1

Quelle	AKUSTIM	ZEIT	Quadratsumme vom Typ III	df	Mittel der Quadrate	F
AKUSTIM	Linear		3491,533	1	3491,533	6,479
	Quadratisch		1069,400	1	1069,400	,940
Fehler(AKUSTIM)	Linear		9700,533	18	538,919	
	Quadratisch		20482,694	18	1137,927	
ZEIT		Linear	562,637	1	562,637	1,837
		Quadratisch	319,078	1	319,078	3,880
Fehler(ZEIT)		Linear	5513,663	18	306,315	
		Quadratisch	1480,372	18	82,243	
AKUSTIM * ZEIT	Linear	Linear	429,590	1	429,590	1,598
		Quadratisch	1,582	1	1,582	,014
	Quadratisch	Linear	3,120	1	3,120	,017
		Quadratisch	9,350	1	9,350	,128
Fehler(AKUSTIM* ZEIT)	Linear	Linear	4838,970	18	268,832	
		Quadratisch	2001,127	18	111,174	
	Quadratisch	Linear	3401,118	18	188,951	
		Quadratisch	1316,507	18	73,139	

Tests der Innersubjektkontraste

Maß: MASS_1

Quelle	AKUSTIM	ZEIT	Signifikanz	Partielles Eta-Quadrat
AKUSTIM	Linear		,020	,265
	Quadratisch		,345	,050
Fehler(AKUSTIM)	Linear			
	Quadratisch			
ZEIT		Linear	,192	,093
		Quadratisch	,064	,177
Fehler(ZEIT)		Linear		
		Quadratisch		
AKUSTIM * ZEIT	Linear	Linear	,222	,082
		Quadratisch	,906	,001
	Quadratisch	Linear	,899	,001
		Quadratisch	,725	,007
Fehler(AKUSTIM* ZEIT)	Linear	Linear		
		Quadratisch		
	Quadratisch	Linear		
		Quadratisch		

Tests der Zwischensubjekteffekte

Maß: MASS_1
Transformierte Variable: Mittel

Quelle	Quadratsumme vom Typ III	df	Mittel der Quadrate	F	Signifikanz	Partielles Eta-Quadrat
Intercept	29557584,110	1	29557584	7209,034	,000	,998
Fehler	73801,365	18	4100,076			

Allgemeines Lineares Modell - ANOVA Meßwertwiederholungen für N-N Interval Varianz (VA)

Innersubjektfaktoren

Maß: MASS_1

AKUSTIM	ZEIT	Abhängige Variable
1	1	CBN2VA
	2	CDN2VA
	3	CAN2VA
2	1	LBN2VA
	2	LDN2VA
	3	LAN2VA
3	1	MBN2VA
	2	MDN2VA
	3	MAN2VA

Deskriptive Statistiken

	Mittelwert	Standardabweichung	N
CBN2VA	234,6784	200,59015	19
CDN2VA	318,8521	440,00444	19
CAN2VA	385,1389	389,61398	19
LBN2VA	383,3174	698,88493	19
LDN2VA	549,3737	620,78063	19
LAN2VA	357,1379	371,72687	19
MBN2VA	312,9416	238,42643	19
MDN2VA	340,3695	494,68323	19
MAN2VA	446,5347	610,35232	19

Multivariate Tests[b]

Effekt		Wert	F	Hypothese df	Fehler df
AKUSTIM	Pillai-Spur	,075	,688[a]	2,000	17,000
	Wilks-Lambda	,925	,688[a]	2,000	17,000
	Hotelling-Spur	,081	,688[a]	2,000	17,000
	Größte charakteristische Wurzel nach Roy	,081	,688[a]	2,000	17,000
ZEIT	Pillai-Spur	,167	1,707[a]	2,000	17,000
	Wilks-Lambda	,833	1,707[a]	2,000	17,000
	Hotelling-Spur	,201	1,707[a]	2,000	17,000
	Größte charakteristische Wurzel nach Roy	,201	1,707[a]	2,000	17,000
AKUSTIM * ZEIT	Pillai-Spur	,273	1,411[a]	4,000	15,000
	Wilks-Lambda	,727	1,411[a]	4,000	15,000
	Hotelling-Spur	,376	1,411[a]	4,000	15,000
	Größte charakteristische Wurzel nach Roy	,376	1,411[a]	4,000	15,000

Multivariate Tests[b]

Effekt		Signifikanz	Partielles Eta-Quadrat
AKUSTIM	Pillai-Spur	,516	,075
	Wilks-Lambda	,516	,075
	Hotelling-Spur	,516	,075
	Größte charakteristische Wurzel nach Roy	,516	,075
ZEIT	Pillai-Spur	,211	,167
	Wilks-Lambda	,211	,167
	Hotelling-Spur	,211	,167
	Größte charakteristische Wurzel nach Roy	,211	,167
AKUSTIM * ZEIT	Pillai-Spur	,278	,273
	Wilks-Lambda	,278	,273
	Hotelling-Spur	,278	,273
	Größte charakteristische Wurzel nach Roy	,278	,273

a. Exakte Statistik

b.
Design: Intercept
Innersubjekt-Design: AKUSTIM+ZEIT+AKUSTIM*ZEIT

Mauchly-Test auf Sphärizität[b]

Maß: MASS_1

Innersubjekteffekt	Mauchly-W	Approximiertes Chi-Quadrat	df	Signifikanz
AKUSTIM	,656	7,172	2	,028
ZEIT	,785	4,125	2	,127
AKUSTIM * ZEIT	,177	28,424	9	,001

Prüft die Nullhypothese, daß sich die Fehlerkovarianz-Matrix der orthonormalisierten transformierten abhängigen Variablen proportional zur Einheitsmatrix verhält.

Mauchly-Test auf Sphärizität[b]

Maß: MASS_1

Innersubjekteffekt	Epsilon[a]		
	Greenhouse-Geisser	Huynh-Feldt	Untergrenze
AKUSTIM	,744	,795	,500
ZEIT	,823	,895	,500
AKUSTIM * ZEIT	,512	,578	,250

Prüft die Nullhypothese, daß sich die Fehlerkovarianz-Matrix der orthonormalisierten transformierten abhängigen Variablen proportional zur Einheitsmatrix verhält.

a. Kann zum Korrigieren der Freiheitsgrade für die gemittelten Signifikanztests verwendet werden. In der Tabelle mit den Tests der Effekte innerhalb der Subjekte werden korrigierte Tests angezeigt.

b.
Design: Intercept
Innersubjekt-Design: AKUSTIM+ZEIT+AKUSTIM*ZEIT

Tests der Innersubjekteffekte

Maß: MASS_1

Quelle		Quadratsumme vom Typ III	df	Mittel der Quadrate	F
AKUSTIM	Sphärizität angenommen	391367,027	2	195683,513	1,142
	Greenhouse-Geisser	391367,027	1,488	263033,490	1,142
	Huynh-Feldt	391367,027	1,591	245994,540	1,142
	Untergrenze	391367,027	1,000	391367,027	1,142
Fehler(AKUSTIM)	Sphärizität angenommen	6168707,814	36	171352,995	
	Greenhouse-Geisser	6168707,814	26,782	230328,940	
	Huynh-Feldt	6168707,814	28,637	215408,547	
	Untergrenze	6168707,814	18,000	342705,990	
ZEIT	Sphärizität angenommen	303967,086	2	151983,543	1,604
	Greenhouse-Geisser	303967,086	1,646	184725,395	1,604
	Huynh-Feldt	303967,086	1,789	169871,414	1,604
	Untergrenze	303967,086	1,000	303967,086	1,604
Fehler(ZEIT)	Sphärizität angenommen	3410348,672	36	94731,908	
	Greenhouse-Geisser	3410348,672	29,619	115140,026	
	Huynh-Feldt	3410348,672	32,209	105881,484	
	Untergrenze	3410348,672	18,000	189463,815	
AKUSTIM * ZEIT	Sphärizität angenommen	514316,506	4	128579,127	1,010
	Greenhouse-Geisser	514316,506	2,046	251319,880	1,010
	Huynh-Feldt	514316,506	2,312	222466,144	1,010
	Untergrenze	514316,506	1,000	514316,506	1,010
Fehler(AKUSTIM* ZEIT)	Sphärizität angenommen	9163783,502	72	127274,771	
	Greenhouse-Geisser	9163783,502	36,836	248770,395	
	Huynh-Feldt	9163783,502	41,614	220209,362	
	Untergrenze	9163783,502	18,000	509099,083	

Tests der Innersubjekteffekte

Maß: MASS_1

Quelle		Signifikanz	Partielles Eta-Quadrat
AKUSTIM	Sphärizität angenommen	,330	,060
	Greenhouse-Geisser	,319	,060
	Huynh-Feldt	,322	,060
	Untergrenze	,299	,060
Fehler(AKUSTIM)	Sphärizität angenommen		
	Greenhouse-Geisser		
	Huynh-Feldt		
	Untergrenze		
ZEIT	Sphärizität angenommen	,215	,082
	Greenhouse-Geisser	,220	,082
	Huynh-Feldt	,218	,082
	Untergrenze	,221	,082
Fehler(ZEIT)	Sphärizität angenommen		
	Greenhouse-Geisser		
	Huynh-Feldt		
	Untergrenze		
AKUSTIM * ZEIT	Sphärizität angenommen	,408	,053
	Greenhouse-Geisser	,376	,053
	Huynh-Feldt	,382	,053
	Untergrenze	,328	,053
Fehler(AKUSTIM* ZEIT)	Sphärizität angenommen		
	Greenhouse-Geisser		
	Huynh-Feldt		
	Untergrenze		

Tests der Innersubjektkontraste

Maß: MASS_1

Quelle	AKUSTIM	ZEIT	Quadratsumme vom Typ III	df	Mittel der Quadrate	F
AKUSTIM	Linear		82263,048	1	82263,048	,663
	Quadratisch		309103,978	1	309103,978	1,414
Fehler(AKUSTIM)	Linear		2232527,363	18	124029,298	
	Quadratisch		3936180,451	18	218676,692	
ZEIT		Linear	210580,510	1	210580,510	3,527
		Quadratisch	93386,576	1	93386,576	,720
Fehler(ZEIT)		Linear	1074701,529	18	59705,640	
		Quadratisch	2335647,144	18	129758,175	
AKUSTIM * ZEIT	Linear	Linear	1351,414	1	1351,414	,014
		Quadratisch	14782,377	1	14782,377	,272
	Quadratisch	Linear	179191,310	1	179191,310	,635
		Quadratisch	318991,406	1	318991,406	4,037
Fehler(AKUSTIM* ZEIT)	Linear	Linear	1686350,829	18	93686,157	
		Quadratisch	979138,558	18	54396,587	
	Quadratisch	Linear	5075851,921	18	281991,773	
		Quadratisch	1422442,194	18	79024,566	

Tests der Innersubjektkontraste

Maß: MASS_1

Quelle	AKUSTIM	ZEIT	Signifikanz	Partielles Eta-Quadrat
AKUSTIM	Linear		,426	,036
	Quadratisch		,250	,073
Fehler(AKUSTIM)	Linear			
	Quadratisch			
ZEIT		Linear	,077	,164
		Quadratisch	,407	,038
Fehler(ZEIT)		Linear		
		Quadratisch		
AKUSTIM * ZEIT	Linear	Linear	,906	,001
		Quadratisch	,609	,015
	Quadratisch	Linear	,436	,034
		Quadratisch	,060	,183
Fehler(AKUSTIM* ZEIT)	Linear	Linear		
		Quadratisch		
	Quadratisch	Linear		
		Quadratisch		

Tests der Zwischensubjekteffekte

Maß: MASS_1
Transformierte Variable: Mittel

Quelle	Quadratsumme vom Typ III	df	Mittel der Quadrate	F	Signifikanz	Partielles Eta-Quadrat
Intercept	23386625,388	1	23386625	22,696	,000	,558
Fehler	18548076,415	18	1030448,7			

Allgemeines Lineares Modell - ANOVA Meßwertwiederholungen für N-N Interval Standard Abweichung (SA)

Innersubjektfaktoren

Maß: MASS_1

AKUSTIM	ZEIT	Abhängige Variable
1	1	CBN2SA
	2	CDN2SA
	3	CAN2SA
2	1	LBN2SA
	2	LDN2SA
	3	LAN2SA
3	1	MBN2SA
	2	MDN2SA
	3	MAN2SA

Deskriptive Statistiken

	Mittelwert	Standardabweichung	N
CBN2SA	13,7500	6,93720	19
CDN2SA	14,7074	10,40298	19
CAN2SA	17,4095	9,30324	19
LBN2SA	15,3579	12,47524	19
LDN2SA	20,4321	11,80177	19
LAN2SA	16,8979	8,70958	19
MBN2SA	16,5126	6,93225	19
MDN2SA	15,6726	10,00242	19
MAN2SA	18,3637	10,74276	19

Multivariate Tests[b]

Effekt		Wert	F	Hypothese df	Fehler df
AKUSTIM	Pillai-Spur	,079	,726[a]	2,000	17,000
	Wilks-Lambda	,921	,726[a]	2,000	17,000
	Hotelling-Spur	,085	,726[a]	2,000	17,000
	Größte charakteristische Wurzel nach Roy	,085	,726[a]	2,000	17,000
ZEIT	Pillai-Spur	,182	1,888[a]	2,000	17,000
	Wilks-Lambda	,818	1,888[a]	2,000	17,000
	Hotelling-Spur	,222	1,888[a]	2,000	17,000
	Größte charakteristische Wurzel nach Roy	,222	1,888[a]	2,000	17,000
AKUSTIM * ZEIT	Pillai-Spur	,313	1,708[a]	4,000	15,000
	Wilks-Lambda	,687	1,708[a]	4,000	15,000
	Hotelling-Spur	,455	1,708[a]	4,000	15,000
	Größte charakteristische Wurzel nach Roy	,455	1,708[a]	4,000	15,000

Multivariate Tests[b]

Effekt		Signifikanz	Partielles Eta-Quadrat
AKUSTIM	Pillai-Spur	,498	,079
	Wilks-Lambda	,498	,079
	Hotelling-Spur	,498	,079
	Größte charakteristische Wurzel nach Roy	,498	,079
ZEIT	Pillai-Spur	,182	,182
	Wilks-Lambda	,182	,182
	Hotelling-Spur	,182	,182
	Größte charakteristische Wurzel nach Roy	,182	,182
AKUSTIM * ZEIT	Pillai-Spur	,201	,313
	Wilks-Lambda	,201	,313
	Hotelling-Spur	,201	,313
	Größte charakteristische Wurzel nach Roy	,201	,313

a. Exakte Statistik

b.
Design: Intercept
Innersubjekt-Design: AKUSTIM+ZEIT+AKUSTIM*ZEIT

Mauchly-Test auf Sphärizität[b]

Maß: MASS_1

Innersubjekteffekt	Mauchly-W	Approximiertes Chi-Quadrat	df	Signifikanz
AKUSTIM	,833	3,109	2	,211
ZEIT	,822	3,333	2	,189
AKUSTIM * ZEIT	,322	18,619	9	,029

Prüft die Nullhypothese, daß sich die Fehlerkovarianz-Matrix der orthonormalisierten transformierten abhängigen Variablen proportional zur Einheitsmatrix verhält.

Mauchly-Test auf Sphärizität[b]

Maß: MASS_1

Innersubjekteffekt	Epsilon[a]		
	Greenhouse-Geisser	Huynh-Feldt	Untergrenze
AKUSTIM	,857	,938	,500
ZEIT	,849	,928	,500
AKUSTIM * ZEIT	,652	,772	,250

Prüft die Nullhypothese, daß sich die Fehlerkovarianz-Matrix der orthonormalisierten transformierten abhängigen Variablen proportional zur Einheitsmatrix verhält.

a. Kann zum Korrigieren der Freiheitsgrade für die gemittelten Signifikanztests verwendet werden. In der Tabelle mit den Tests der Effekte innerhalb der Subjekte werden korrigierte Tests angezeigt.

b.
Design: Intercept
Innersubjekt-Design: AKUSTIM+ZEIT+AKUSTIM*ZEIT

Tests der Innersubjekteffekte

Maß: MASS_1

Quelle		Quadratsumme vom Typ III	df	Mittel der Quadrate	F
AKUSTIM	Sphärizität angenommen	154,162	2	77,081	1,000
	Greenhouse-Geisser	154,162	1,714	89,964	1,000
	Huynh-Feldt	154,162	1,876	82,162	1,000
	Untergrenze	154,162	1,000	154,162	1,000
Fehler(AKUSTIM)	Sphärizität angenommen	2774,219	36	77,062	
	Greenhouse-Geisser	2774,219	30,845	89,941	
	Huynh-Feldt	2774,219	33,774	82,142	
	Untergrenze	2774,219	18,000	154,123	
ZEIT	Sphärizität angenommen	169,138	2	84,569	1,540
	Greenhouse-Geisser	169,138	1,698	99,627	1,540
	Huynh-Feldt	169,138	1,856	91,132	1,540
	Untergrenze	169,138	1,000	169,138	1,540
Fehler(ZEIT)	Sphärizität angenommen	1977,165	36	54,921	
	Greenhouse-Geisser	1977,165	30,559	64,700	
	Huynh-Feldt	1977,165	33,408	59,183	
	Untergrenze	1977,165	18,000	109,843	
AKUSTIM * ZEIT	Sphärizität angenommen	296,953	4	74,238	1,515
	Greenhouse-Geisser	296,953	2,607	113,888	1,515
	Huynh-Feldt	296,953	3,089	96,146	1,515
	Untergrenze	296,953	1,000	296,953	1,515
Fehler(AKUSTIM* ZEIT)	Sphärizität angenommen	3528,682	72	49,009	
	Greenhouse-Geisser	3528,682	46,933	75,185	
	Huynh-Feldt	3528,682	55,594	63,472	
	Untergrenze	3528,682	18,000	196,038	

Tests der Innersubjekteffekte

Maß: MASS_1

Quelle		Signifikanz	Partielles Eta-Quadrat
AKUSTIM	Sphärizität angenommen	,378	,053
	Greenhouse-Geisser	,368	,053
	Huynh-Feldt	,374	,053
	Untergrenze	,331	,053
Fehler(AKUSTIM)	Sphärizität angenommen		
	Greenhouse-Geisser		
	Huynh-Feldt		
	Untergrenze		
ZEIT	Sphärizität angenommen	,228	,079
	Greenhouse-Geisser	,231	,079
	Huynh-Feldt	,230	,079
	Untergrenze	,231	,079
Fehler(ZEIT)	Sphärizität angenommen		
	Greenhouse-Geisser		
	Huynh-Feldt		
	Untergrenze		
AKUSTIM * ZEIT	Sphärizität angenommen	,207	,078
	Greenhouse-Geisser	,226	,078
	Huynh-Feldt	,220	,078
	Untergrenze	,234	,078
Fehler(AKUSTIM* ZEIT)	Sphärizität angenommen		
	Greenhouse-Geisser		
	Huynh-Feldt		
	Untergrenze		

Tests der Innersubjektkontraste

Maß: MASS_1

Quelle	AKUSTIM	ZEIT	Quadratsumme vom Typ III	df	Mittel der Quadrate	F
AKUSTIM	Linear		69,420	1	69,420	1,169
	Quadratisch		84,742	1	84,742	,894
Fehler(AKUSTIM)	Linear		1068,921	18	59,385	
	Quadratisch		1705,297	18	94,739	
ZEIT		Linear	157,415	1	157,415	3,924
		Quadratisch	11,723	1	11,723	,168
Fehler(ZEIT)		Linear	722,078	18	40,115	
		Quadratisch	1255,087	18	69,727	
AKUSTIM * ZEIT	Linear	Linear	15,534	1	15,534	,426
		Quadratisch	5,052	1	5,052	,200
	Quadratisch	Linear	9,353	1	9,353	,101
		Quadratisch	267,013	1	267,013	6,462
Fehler(AKUSTIM* ZEIT)	Linear	Linear	656,410	18	36,467	
		Quadratisch	455,436	18	25,302	
	Quadratisch	Linear	1673,069	18	92,948	
		Quadratisch	743,768	18	41,320	

Tests der Innersubjektkontraste

Maß: MASS_1

Quelle	AKUSTIM	ZEIT	Signifikanz	Partielles Eta-Quadrat
AKUSTIM	Linear		,294	,061
	Quadratisch		,357	,047
Fehler(AKUSTIM)	Linear			
	Quadratisch			
ZEIT		Linear	,063	,179
		Quadratisch	,687	,009
Fehler(ZEIT)		Linear		
		Quadratisch		
AKUSTIM * ZEIT	Linear	Linear	,522	,023
		Quadratisch	,660	,011
	Quadratisch	Linear	,755	,006
		Quadratisch	,020	,264
Fehler(AKUSTIM* ZEIT)	Linear	Linear		
		Quadratisch		
	Quadratisch	Linear		
		Quadratisch		

Tests der Zwischensubjekteffekte

Maß: MASS_1
Transformierte Variable: Mittel

Quelle	Quadratsumme vom Typ III	df	Mittel der Quadrate	F	Signifikanz	Partielles Eta-Quadrat
Intercept	46934,029	1	46934,029	112,504	,000	,862
Fehler	7509,147	18	417,175			

Allgemeines Lineares Modell - ANOVA Meßwertwiederholungen für pnn 6,25% (P6)

Innersubjektfaktoren

Maß: MASS_1

AKUSTIM	ZEIT	Abhängige Variable
1	1	CBN2P6
	2	CDN2P6
	3	CAN2P6
2	1	LBN2P6
	2	LDN2P6
	3	LAN2P6
3	1	MBN2P6
	2	MDN2P6
	3	MAN2P6

Deskriptive Statistiken

	Mittelwert	Standardabweichung	N
CBN2P6	1,5474	3,28726	19
CDN2P6	,9374	1,77389	19
CAN2P6	1,1211	2,12722	19
LBN2P6	3,4868	6,68253	19
LDN2P6	5,4547	6,81119	19
LAN2P6	3,3905	5,28049	19
MBN2P6	3,5279	7,20612	19
MDN2P6	3,9263	7,68297	19
MAN2P6	5,6668	13,10520	19

Multivariate Tests[b]

Effekt		Wert	F	Hypothese df	Fehler df
AKUSTIM	Pillai-Spur	,209	2,241[a]	2,000	17,000
	Wilks-Lambda	,791	2,241[a]	2,000	17,000
	Hotelling-Spur	,264	2,241[a]	2,000	17,000
	Größte charakteristische Wurzel nach Roy	,264	2,241[a]	2,000	17,000
ZEIT	Pillai-Spur	,106	1,006[a]	2,000	17,000
	Wilks-Lambda	,894	1,006[a]	2,000	17,000
	Hotelling-Spur	,118	1,006[a]	2,000	17,000
	Größte charakteristische Wurzel nach Roy	,118	1,006[a]	2,000	17,000
AKUSTIM * ZEIT	Pillai-Spur	,359	2,100[a]	4,000	15,000
	Wilks-Lambda	,641	2,100[a]	4,000	15,000
	Hotelling-Spur	,560	2,100[a]	4,000	15,000
	Größte charakteristische Wurzel nach Roy	,560	2,100[a]	4,000	15,000

Multivariate Tests[b]

Effekt		Signifikanz	Partielles Eta-Quadrat
AKUSTIM	Pillai-Spur	,137	,209
	Wilks-Lambda	,137	,209
	Hotelling-Spur	,137	,209
	Größte charakteristische Wurzel nach Roy	,137	,209
ZEIT	Pillai-Spur	,386	,106
	Wilks-Lambda	,386	,106
	Hotelling-Spur	,386	,106
	Größte charakteristische Wurzel nach Roy	,386	,106
AKUSTIM * ZEIT	Pillai-Spur	,131	,359
	Wilks-Lambda	,131	,359
	Hotelling-Spur	,131	,359
	Größte charakteristische Wurzel nach Roy	,131	,359

a. Exakte Statistik

b.
Design: Intercept
Innersubjekt-Design: AKUSTIM+ZEIT+AKUSTIM*ZEIT

Mauchly-Test auf Sphärizität[b]

Maß: MASS_1

Innersubjekteffekt	Mauchly-W	Approximiertes Chi-Quadrat	df	Signifikanz
AKUSTIM	,696	6,157	2	,046
ZEIT	,326	19,049	2	,000
AKUSTIM * ZEIT	,113	35,773	9	,000

Prüft die Nullhypothese, daß sich die Fehlerkovarianz-Matrix der orthonormalisierten transformierten abhängigen Variablen proportional zur Einheitsmatrix verhält.

Mauchly-Test auf Sphärizität[b]

Maß: MASS_1

Innersubjekteffekt	Epsilon[a]		
	Greenhouse-Geisser	Huynh-Feldt	Untergrenze
AKUSTIM	,767	,824	,500
ZEIT	,597	,616	,500
AKUSTIM * ZEIT	,439	,483	,250

Prüft die Nullhypothese, daß sich die Fehlerkovarianz-Matrix der orthonormalisierten transformierten abhängigen Variablen proportional zur Einheitsmatrix verhält.

a. Kann zum Korrigieren der Freiheitsgrade für die gemittelten Signifikanztests verwendet werden. In der Tabelle mit den Tests der Effekte innerhalb der Subjekte werden korrigierte Tests angezeigt.

b.
Design: Intercept
Innersubjekt-Design: AKUSTIM+ZEIT+AKUSTIM*ZEIT

Tests der Innersubjekteffekte

Maß: MASS_1

Quelle		Quadratsumme vom Typ III	df	Mittel der Quadrate	F
AKUSTIM	Sphärizität angenommen	353,213	2	176,606	3,214
	Greenhouse-Geisser	353,213	1,534	230,266	3,214
	Huynh-Feldt	353,213	1,649	214,259	3,214
	Untergrenze	353,213	1,000	353,213	3,214
Fehler(AKUSTIM)	Sphärizität angenommen	1977,888	36	54,941	
	Greenhouse-Geisser	1977,888	27,611	71,634	
	Huynh-Feldt	1977,888	29,674	66,655	
	Untergrenze	1977,888	18,000	109,883	
ZEIT	Sphärizität angenommen	12,069	2	6,034	,196
	Greenhouse-Geisser	12,069	1,195	10,101	,196
	Huynh-Feldt	12,069	1,232	9,797	,196
	Untergrenze	12,069	1,000	12,069	,196
Fehler(ZEIT)	Sphärizität angenommen	1108,877	36	30,802	
	Greenhouse-Geisser	1108,877	21,507	51,559	
	Huynh-Feldt	1108,877	22,173	50,009	
	Untergrenze	1108,877	18,000	61,604	
AKUSTIM * ZEIT	Sphärizität angenommen	92,391	4	23,098	1,004
	Greenhouse-Geisser	92,391	1,755	52,632	1,004
	Huynh-Feldt	92,391	1,930	47,870	1,004
	Untergrenze	92,391	1,000	92,391	1,004
Fehler(AKUSTIM* ZEIT)	Sphärizität angenommen	1656,078	72	23,001	
	Greenhouse-Geisser	1656,078	31,598	52,411	
	Huynh-Feldt	1656,078	34,741	47,669	
	Untergrenze	1656,078	18,000	92,004	

Tests der Innersubjekteffekte

Maß: MASS_1

Quelle		Signifikanz	Partielles Eta-Quadrat
AKUSTIM	Sphärizität angenommen	,052	,152
	Greenhouse-Geisser	,067	,152
	Huynh-Feldt	,063	,152
	Untergrenze	,090	,152
Fehler(AKUSTIM)	Sphärizität angenommen		
	Greenhouse-Geisser		
	Huynh-Feldt		
	Untergrenze		
ZEIT	Sphärizität angenommen	,823	,011
	Greenhouse-Geisser	,706	,011
	Huynh-Feldt	,714	,011
	Untergrenze	,663	,011
Fehler(ZEIT)	Sphärizität angenommen		
	Greenhouse-Geisser		
	Huynh-Feldt		
	Untergrenze		
AKUSTIM * ZEIT	Sphärizität angenommen	,411	,053
	Greenhouse-Geisser	,368	,053
	Huynh-Feldt	,374	,053
	Untergrenze	,330	,053
Fehler(AKUSTIM* ZEIT)	Sphärizität angenommen		
	Greenhouse-Geisser		
	Huynh-Feldt		
	Untergrenze		

Tests der Innersubjektkontraste

Maß: MASS_1

Quelle	AKUSTIM	ZEIT	Quadratsumme vom Typ III	df	Mittel der Quadrate	F
AKUSTIM	Linear		286,711	1	286,711	3,464
	Quadratisch		66,502	1	66,502	2,452
Fehler(AKUSTIM)	Linear		1489,682	18	82,760	
	Quadratisch		488,206	18	27,123	
ZEIT		Linear	8,273	1	8,273	,586
		Quadratisch	3,796	1	3,796	,080
Fehler(ZEIT)		Linear	254,233	18	14,124	
		Quadratisch	854,644	18	47,480	
AKUSTIM * ZEIT	Linear	Linear	31,258	1	31,258	1,110
		Quadratisch	,476	1	,476	,012
	Quadratisch	Linear	5,748	1	5,748	,339
		Quadratisch	54,910	1	54,910	6,347
Fehler(AKUSTIM* ZEIT)	Linear	Linear	506,883	18	28,160	
		Quadratisch	688,448	18	38,247	
	Quadratisch	Linear	305,023	18	16,946	
		Quadratisch	155,724	18	8,651	

Tests der Innersubjektkontraste

Maß: MASS_1

Quelle	AKUSTIM	ZEIT	Signifikanz	Partielles Eta-Quadrat
AKUSTIM	Linear		,079	,161
	Quadratisch		,135	,120
Fehler(AKUSTIM)	Linear			
	Quadratisch			
ZEIT		Linear	,454	,032
		Quadratisch	,781	,004
Fehler(ZEIT)		Linear		
		Quadratisch		
AKUSTIM * ZEIT	Linear	Linear	,306	,058
		Quadratisch	,912	,001
	Quadratisch	Linear	,568	,018
		Quadratisch	,021	,261
Fehler(AKUSTIM* ZEIT)	Linear	Linear		
		Quadratisch		
	Quadratisch	Linear		
		Quadratisch		

Tests der Zwischensubjekteffekte

Maß: MASS_1
Transformierte Variable: Mittel

Quelle	Quadratsumme vom Typ III	df	Mittel der Quadrate	F	Signifikanz	Partielles Eta-Quadrat
Intercept	1782,670	1	1782,670	11,382	,003	,387
Fehler	2819,178	18	156,621			

Allgemeines Lineares Modell - ANOVA Meßwertwiederholungen für RMSSD (RM)

Innersubjektfaktoren

Maß: MASS_1

AKUSTIM	ZEIT	Abhängige Variable
1	1	CBN2RM
	2	CDN2RM
	3	CAN2RM
2	1	LBN2RM
	2	LDN2RM
	3	LAN2RM
3	1	MBN2RM
	2	MDN2RM
	3	MAN2RM

Deskriptive Statistiken

	Mittelwert	Standardabweichung	N
CBN2RM	5,2884	3,16176	19
CDN2RM	5,2379	2,95592	19
CAN2RM	5,3116	2,78189	19
LBN2RM	6,7847	5,10015	19
LDN2RM	8,0516	4,28898	19
LAN2RM	6,6058	3,55099	19
MBN2RM	7,2458	5,25889	19
MDN2RM	7,1868	5,01118	19
MAN2RM	7,8742	7,59487	19

Multivariate Tests[b]

Effekt		Wert	F	Hypothese df	Fehler df
AKUSTIM	Pillai-Spur	,208	2,231[a]	2,000	17,000
	Wilks-Lambda	,792	2,231[a]	2,000	17,000
	Hotelling-Spur	,262	2,231[a]	2,000	17,000
	Größte charakteristische Wurzel nach Roy	,262	2,231[a]	2,000	17,000
ZEIT	Pillai-Spur	,030	,266[a]	2,000	17,000
	Wilks-Lambda	,970	,266[a]	2,000	17,000
	Hotelling-Spur	,031	,266[a]	2,000	17,000
	Größte charakteristische Wurzel nach Roy	,031	,266[a]	2,000	17,000
AKUSTIM * ZEIT	Pillai-Spur	,353	2,043[a]	4,000	15,000
	Wilks-Lambda	,647	2,043[a]	4,000	15,000
	Hotelling-Spur	,545	2,043[a]	4,000	15,000
	Größte charakteristische Wurzel nach Roy	,545	2,043[a]	4,000	15,000

Multivariate Tests[b]

Effekt		Signifikanz	Partielles Eta-Quadrat
AKUSTIM	Pillai-Spur	,138	,208
	Wilks-Lambda	,138	,208
	Hotelling-Spur	,138	,208
	Größte charakteristische Wurzel nach Roy	,138	,208
ZEIT	Pillai-Spur	,770	,030
	Wilks-Lambda	,770	,030
	Hotelling-Spur	,770	,030
	Größte charakteristische Wurzel nach Roy	,770	,030
AKUSTIM * ZEIT	Pillai-Spur	,140	,353
	Wilks-Lambda	,140	,353
	Hotelling-Spur	,140	,353
	Größte charakteristische Wurzel nach Roy	,140	,353

a. Exakte Statistik

b.
Design: Intercept
Innersubjekt-Design: AKUSTIM+ZEIT+AKUSTIM*ZEIT

Mauchly-Test auf Sphärizität[b]

Maß: MASS_1

Innersubjekteffekt	Mauchly-W	Approximiertes Chi-Quadrat	df	Signifikanz
AKUSTIM	,896	1,874	2	,392
ZEIT	,785	4,107	2	,128
AKUSTIM * ZEIT	,140	32,246	9	,000

Prüft die Nullhypothese, daß sich die Fehlerkovarianz-Matrix der orthonormalisierten transformierten abhängigen Variablen proportional zur Einheitsmatrix verhält.

Mauchly-Test auf Sphärizität[b]

Maß: MASS_1

Innersubjekteffekt	Epsilon[a]		
	Greenhouse-Geisser	Huynh-Feldt	Untergrenze
AKUSTIM	,905	1,000	,500
ZEIT	,823	,895	,500
AKUSTIM * ZEIT	,511	,578	,250

Prüft die Nullhypothese, daß sich die Fehlerkovarianz-Matrix der orthonormalisierten transformierten abhängigen Variablen proportional zur Einheitsmatrix verhält.

a. Kann zum Korrigieren der Freiheitsgrade für die gemittelten Signifikanztests verwendet werden. In der Tabelle mit den Tests der Effekte innerhalb der Subjekte werden korrigierte Tests angezeigt.

b.
Design: Intercept
Innersubjekt-Design: AKUSTIM+ZEIT+AKUSTIM*ZEIT

Tests der Innersubjekteffekte

Maß: MASS_1

Quelle		Quadratsumme vom Typ III	df	Mittel der Quadrate	F
AKUSTIM	Sphärizität angenommen	156,227	2	78,113	3,096
	Greenhouse-Geisser	156,227	1,811	86,267	3,096
	Huynh-Feldt	156,227	2,000	78,113	3,096
	Untergrenze	156,227	1,000	156,227	3,096
Fehler(AKUSTIM)	Sphärizität angenommen	908,382	36	25,233	
	Greenhouse-Geisser	908,382	32,598	27,867	
	Huynh-Feldt	908,382	36,000	25,233	
	Untergrenze	908,382	18,000	50,466	
ZEIT	Sphärizität angenommen	4,289	2	2,145	,208
	Greenhouse-Geisser	4,289	1,647	2,605	,208
	Huynh-Feldt	4,289	1,791	2,395	,208
	Untergrenze	4,289	1,000	4,289	,208
Fehler(ZEIT)	Sphärizität angenommen	371,048	36	10,307	
	Greenhouse-Geisser	371,048	29,638	12,519	
	Huynh-Feldt	371,048	32,234	11,511	
	Untergrenze	371,048	18,000	20,614	
AKUSTIM * ZEIT	Sphärizität angenommen	24,886	4	6,221	,893
	Greenhouse-Geisser	24,886	2,046	12,164	,893
	Huynh-Feldt	24,886	2,311	10,768	,893
	Untergrenze	24,886	1,000	24,886	,893
Fehler(AKUSTIM* ZEIT)	Sphärizität angenommen	501,539	72	6,966	
	Greenhouse-Geisser	501,539	36,825	13,619	
	Huynh-Feldt	501,539	41,599	12,056	
	Untergrenze	501,539	18,000	27,863	

Tests der Innersubjekteffekte

Maß: MASS_1

Quelle		Signifikanz	Partielles Eta-Quadrat
AKUSTIM	Sphärizität angenommen	,057	,147
	Greenhouse-Geisser	,063	,147
	Huynh-Feldt	,057	,147
	Untergrenze	,095	,147
Fehler(AKUSTIM)	Sphärizität angenommen		
	Greenhouse-Geisser		
	Huynh-Feldt		
	Untergrenze		
ZEIT	Sphärizität angenommen	,813	,011
	Greenhouse-Geisser	,771	,011
	Huynh-Feldt	,789	,011
	Untergrenze	,654	,011
Fehler(ZEIT)	Sphärizität angenommen		
	Greenhouse-Geisser		
	Huynh-Feldt		
	Untergrenze		
AKUSTIM * ZEIT	Sphärizität angenommen	,473	,047
	Greenhouse-Geisser	,420	,047
	Huynh-Feldt	,430	,047
	Untergrenze	,357	,047
Fehler(AKUSTIM* ZEIT)	Sphärizität angenommen		
	Greenhouse-Geisser		
	Huynh-Feldt		
	Untergrenze		

Tests der Innersubjektkontraste

Maß: MASS_1

Quelle	AKUSTIM	ZEIT	Quadratsumme vom Typ III	df	Mittel der Quadrate	F
AKUSTIM	Linear		132,516	1	132,516	4,146
	Quadratisch		23,711	1	23,711	1,281
Fehler(AKUSTIM)	Linear		575,308	18	31,962	
	Quadratisch		333,074	18	18,504	
ZEIT		Linear	,707	1	,707	,098
		Quadratisch	3,582	1	3,582	,268
Fehler(ZEIT)		Linear	130,036	18	7,224	
		Quadratisch	241,012	18	13,390	
AKUSTIM * ZEIT	Linear	Linear	1,740	1	1,740	,224
		Quadratisch	,613	1	,613	,065
	Quadratisch	Linear	1,613	1	1,613	,232
		Quadratisch	20,920	1	20,920	5,528
Fehler(AKUSTIM* ZEIT)	Linear	Linear	139,659	18	7,759	
		Quadratisch	168,553	18	9,364	
	Quadratisch	Linear	125,212	18	6,956	
		Quadratisch	68,116	18	3,784	

Tests der Innersubjektkontraste

Maß: MASS_1

Quelle	AKUSTIM	ZEIT	Signifikanz	Partielles Eta-Quadrat
AKUSTIM	Linear		,057	,187
	Quadratisch		,273	,066
Fehler(AKUSTIM)	Linear			
	Quadratisch			
ZEIT		Linear	,758	,005
		Quadratisch	,611	,015
Fehler(ZEIT)		Linear		
		Quadratisch		
AKUSTIM * ZEIT	Linear	Linear	,641	,012
		Quadratisch	,801	,004
	Quadratisch	Linear	,636	,013
		Quadratisch	,030	,235
Fehler(AKUSTIM* ZEIT)	Linear	Linear		
		Quadratisch		
	Quadratisch	Linear		
		Quadratisch		

Tests der Zwischensubjekteffekte

Maß: MASS_1
Transformierte Variable: Mittel

Quelle	Quadratsumme vom Typ III	df	Mittel der Quadrate	F	Signifikanz	Partielles Eta-Quadrat
Intercept	7495,694	1	7495,694	78,905	,000	,814
Fehler	1709,940	18	94,997			

Allgemeines Lineares Modell - ANOVA Meßwertwiederholungen für SDSD (SD)

Innersubjektfaktoren

Maß: MASS_1

AKUSTIM	ZEIT	Abhängige Variable
1	1	CBN2SD
	2	CDN2SD
	3	CAN2SD
2	1	LBN2SD
	2	LDN2SD
	3	LAN2SD
3	1	MBN2SD
	2	MDN2SD
	3	MAN2SD

Deskriptive Statistiken

	Mittelwert	Standardabweichung	N
CBN2SD	4,6432	3,08036	19
CDN2SD	5,9511	5,54012	19
CAN2SD	5,1332	2,69610	19
LBN2SD	5,8284	4,33341	19
LDN2SD	8,4716	5,57250	19
LAN2SD	6,8132	3,72588	19
MBN2SD	7,5789	7,36039	19
MDN2SD	6,2816	4,76095	19
MAN2SD	6,8305	5,63843	19

Multivariate Tests[b]

Effekt		Wert	F	Hypothese df	Fehler df
AKUSTIM	Pillai-Spur	,160	1,617[a]	2,000	17,000
	Wilks-Lambda	,840	1,617[a]	2,000	17,000
	Hotelling-Spur	,190	1,617[a]	2,000	17,000
	Größte charakteristische Wurzel nach Roy	,190	1,617[a]	2,000	17,000
ZEIT	Pillai-Spur	,085	,794[a]	2,000	17,000
	Wilks-Lambda	,915	,794[a]	2,000	17,000
	Hotelling-Spur	,093	,794[a]	2,000	17,000
	Größte charakteristische Wurzel nach Roy	,093	,794[a]	2,000	17,000
AKUSTIM * ZEIT	Pillai-Spur	,352	2,033[a]	4,000	15,000
	Wilks-Lambda	,648	2,033[a]	4,000	15,000
	Hotelling-Spur	,542	2,033[a]	4,000	15,000
	Größte charakteristische Wurzel nach Roy	,542	2,033[a]	4,000	15,000

Multivariate Tests[b]

Effekt		Signifikanz	Partielles Eta-Quadrat
AKUSTIM	Pillai-Spur	,228	,160
	Wilks-Lambda	,228	,160
	Hotelling-Spur	,228	,160
	Größte charakteristische Wurzel nach Roy	,228	,160
ZEIT	Pillai-Spur	,468	,085
	Wilks-Lambda	,468	,085
	Hotelling-Spur	,468	,085
	Größte charakteristische Wurzel nach Roy	,468	,085
AKUSTIM * ZEIT	Pillai-Spur	,141	,352
	Wilks-Lambda	,141	,352
	Hotelling-Spur	,141	,352
	Größte charakteristische Wurzel nach Roy	,141	,352

a. Exakte Statistik

b.
Design: Intercept
Innersubjekt-Design: AKUSTIM+ZEIT+AKUSTIM*ZEIT

Mauchly-Test auf Sphärizität[b]

Maß: MASS_1

Innersubjekteffekt	Mauchly-W	Approximiertes Chi-Quadrat	df	Signifikanz
AKUSTIM	,994	,107	2	,948
ZEIT	,980	,348	2	,840
AKUSTIM * ZEIT	,396	15,193	9	,087

Prüft die Nullhypothese, daß sich die Fehlerkovarianz-Matrix der orthonormalisierten transformierten abhängigen Variablen proportional zur Einheitsmatrix verhält.

Mauchly-Test auf Sphärizität[b]

Maß: MASS_1

Innersubjekteffekt	Epsilon[a]		
	Greenhouse-Geisser	Huynh-Feldt	Untergrenze
AKUSTIM	,994	1,000	,500
ZEIT	,980	1,000	,500
AKUSTIM * ZEIT	,688	,825	,250

Prüft die Nullhypothese, daß sich die Fehlerkovarianz-Matrix der orthonormalisierten transformierten abhängigen Variablen proportional zur Einheitsmatrix verhält.

a. Kann zum Korrigieren der Freiheitsgrade für die gemittelten Signifikanztests verwendet werden. In der Tabelle mit den Tests der Effekte innerhalb der Subjekte werden korrigierte Tests angezeigt.

b.
Design: Intercept
Innersubjekt-Design: AKUSTIM+ZEIT+AKUSTIM*ZEIT

Tests der Innersubjekteffekte

Maß: MASS_1

Quelle		Quadratsumme vom Typ III	df	Mittel der Quadrate	F
AKUSTIM	Sphärizität angenommen	113,626	2	56,813	1,691
	Greenhouse-Geisser	113,626	1,988	57,170	1,691
	Huynh-Feldt	113,626	2,000	56,813	1,691
	Untergrenze	113,626	1,000	113,626	1,691
Fehler(AKUSTIM)	Sphärizität angenommen	1209,153	36	33,588	
	Greenhouse-Geisser	1209,153	35,775	33,799	
	Huynh-Feldt	1209,153	36,000	33,588	
	Untergrenze	1209,153	18,000	67,175	
ZEIT	Sphärizität angenommen	23,822	2	11,911	,893
	Greenhouse-Geisser	23,822	1,960	12,153	,893
	Huynh-Feldt	23,822	2,000	11,911	,893
	Untergrenze	23,822	1,000	23,822	,893
Fehler(ZEIT)	Sphärizität angenommen	480,043	36	13,335	
	Greenhouse-Geisser	480,043	35,284	13,605	
	Huynh-Feldt	480,043	36,000	13,335	
	Untergrenze	480,043	18,000	26,669	
AKUSTIM * ZEIT	Sphärizität angenommen	76,692	4	19,173	1,660
	Greenhouse-Geisser	76,692	2,752	27,867	1,660
	Huynh-Feldt	76,692	3,298	23,253	1,660
	Untergrenze	76,692	1,000	76,692	1,660
Fehler(AKUSTIM* ZEIT)	Sphärizität angenommen	831,748	72	11,552	
	Greenhouse-Geisser	831,748	49,537	16,790	
	Huynh-Feldt	831,748	59,365	14,011	
	Untergrenze	831,748	18,000	46,208	

Tests der Innersubjekteffekte

Maß: MASS_1

Quelle		Signifikanz	Partielles Eta-Quadrat
AKUSTIM	Sphärizität angenommen	,199	,086
	Greenhouse-Geisser	,199	,086
	Huynh-Feldt	,199	,086
	Untergrenze	,210	,086
Fehler(AKUSTIM)	Sphärizität angenommen		
	Greenhouse-Geisser		
	Huynh-Feldt		
	Untergrenze		
ZEIT	Sphärizität angenommen	,418	,047
	Greenhouse-Geisser	,417	,047
	Huynh-Feldt	,418	,047
	Untergrenze	,357	,047
Fehler(ZEIT)	Sphärizität angenommen		
	Greenhouse-Geisser		
	Huynh-Feldt		
	Untergrenze		
AKUSTIM * ZEIT	Sphärizität angenommen	,169	,084
	Greenhouse-Geisser	,191	,084
	Huynh-Feldt	,181	,084
	Untergrenze	,214	,084
Fehler(AKUSTIM* ZEIT)	Sphärizität angenommen		
	Greenhouse-Geisser		
	Huynh-Feldt		
	Untergrenze		

Tests der Innersubjektkontraste

Maß: MASS_1

Quelle	AKUSTIM	ZEIT	Quadratsumme vom Typ III	df	Mittel der Quadrate	F
AKUSTIM	Linear		78,021	1	78,021	2,169
	Quadratisch		35,606	1	35,606	1,141
Fehler(AKUSTIM)	Linear		647,564	18	35,976	
	Quadratisch		561,589	18	31,199	
ZEIT		Linear	1,671	1	1,671	,144
		Quadratisch	22,152	1	22,152	1,473
Fehler(ZEIT)		Linear	209,326	18	11,629	
		Quadratisch	270,718	18	15,040	
AKUSTIM * ZEIT	Linear	Linear	7,285	1	7,285	,498
		Quadratisch	24,981	1	24,981	2,157
	Quadratisch	Linear	7,859	1	7,859	,639
		Quadratisch	36,566	1	36,566	4,760
Fehler(AKUSTIM* ZEIT)	Linear	Linear	263,562	18	14,642	
		Quadratisch	208,429	18	11,579	
	Quadratisch	Linear	221,476	18	12,304	
		Quadratisch	138,280	18	7,682	

Tests der Innersubjektkontraste

Maß: MASS_1

Quelle	AKUSTIM	ZEIT	Signifikanz	Partielles Eta-Quadrat
AKUSTIM	Linear		,158	,108
	Quadratisch		,300	,060
Fehler(AKUSTIM)	Linear			
	Quadratisch			
ZEIT		Linear	,709	,008
		Quadratisch	,241	,076
Fehler(ZEIT)		Linear		
		Quadratisch		
AKUSTIM * ZEIT	Linear	Linear	,490	,027
		Quadratisch	,159	,107
	Quadratisch	Linear	,435	,034
		Quadratisch	,043	,209
Fehler(AKUSTIM* ZEIT)	Linear	Linear		
		Quadratisch		
	Quadratisch	Linear		
		Quadratisch		

Tests der Zwischensubjekteffekte

Maß: MASS_1
Transformierte Variable: Mittel

Quelle	Quadratsumme vom Typ III	df	Mittel der Quadrate	F	Signifikanz	Partielles Eta-Quadrat
Intercept	6987,530	1	6987,530	87,623	,000	,830
Fehler	1435,418	18	79,745			

Allgemeines Lineares Modell - ANOVA Meßwertwiederholungen für RSA (RS)

Innersubjektfaktoren

Maß: MASS_1

AKUSTIM	ZEIT	Abhängige Variable
1	1	CBN2RS
	2	CDN2RS
	3	CAN2RS
2	1	LBN2RS
	2	LDN2RS
	3	LAN2RS
3	1	MBN2RS
	2	MDN2RS
	3	MAN2RS

Deskriptive Statistiken

	Mittelwert	Standardabweichung	N
CBN2RS	4,2958	2,74531	19
CDN2RS	5,6363	5,35416	19
CAN2RS	6,2716	4,47913	19
LBN2RS	5,0242	4,73997	19
LDN2RS	7,2695	5,68674	19
LAN2RS	4,6963	3,24587	19
MBN2RS	5,8021	3,27391	19
MDN2RS	6,0658	6,01550	19
MAN2RS	7,3574	10,05087	19

Multivariate Tests[b]

Effekt		Wert	F	Hypothese df	Fehler df
AKUSTIM	Pillai-Spur	,067	,615[a]	2,000	17,000
	Wilks-Lambda	,933	,615[a]	2,000	17,000
	Hotelling-Spur	,072	,615[a]	2,000	17,000
	Größte charakteristische Wurzel nach Roy	,072	,615[a]	2,000	17,000
ZEIT	Pillai-Spur	,106	1,009[a]	2,000	17,000
	Wilks-Lambda	,894	1,009[a]	2,000	17,000
	Hotelling-Spur	,119	1,009[a]	2,000	17,000
	Größte charakteristische Wurzel nach Roy	,119	1,009[a]	2,000	17,000
AKUSTIM * ZEIT	Pillai-Spur	,409	2,594[a]	4,000	15,000
	Wilks-Lambda	,591	2,594[a]	4,000	15,000
	Hotelling-Spur	,692	2,594[a]	4,000	15,000
	Größte charakteristische Wurzel nach Roy	,692	2,594[a]	4,000	15,000

Multivariate Tests[b]

Effekt		Signifikanz	Partielles Eta-Quadrat
AKUSTIM	Pillai-Spur	,552	,067
	Wilks-Lambda	,552	,067
	Hotelling-Spur	,552	,067
	Größte charakteristische Wurzel nach Roy	,552	,067
ZEIT	Pillai-Spur	,385	,106
	Wilks-Lambda	,385	,106
	Hotelling-Spur	,385	,106
	Größte charakteristische Wurzel nach Roy	,385	,106
AKUSTIM * ZEIT	Pillai-Spur	,079	,409
	Wilks-Lambda	,079	,409
	Hotelling-Spur	,079	,409
	Größte charakteristische Wurzel nach Roy	,079	,409

a. Exakte Statistik

b.
Design: Intercept
Innersubjekt-Design: AKUSTIM+ZEIT+AKUSTIM*ZEIT

Mauchly-Test auf Sphärizität[b]

Maß: MASS_1

Innersubjekteffekt	Mauchly-W	Approximiertes Chi-Quadrat	df	Signifikanz
AKUSTIM	,777	4,282	2	,118
ZEIT	,724	5,495	2	,064
AKUSTIM * ZEIT	,070	43,714	9	,000

Prüft die Nullhypothese, daß sich die Fehlerkovarianz-Matrix der orthonormalisierten transformierten abhängigen Variablen proportional zur Einheitsmatrix verhält.

Mauchly-Test auf Sphärizität[b]

Maß: MASS_1

Innersubjekteffekt	Epsilon[a]		
	Greenhouse-Geisser	Huynh-Feldt	Untergrenze
AKUSTIM	,818	,889	,500
ZEIT	,784	,845	,500
AKUSTIM * ZEIT	,446	,491	,250

Prüft die Nullhypothese, daß sich die Fehlerkovarianz-Matrix der orthonormalisierten transformierten abhängigen Variablen proportional zur Einheitsmatrix verhält.

a. Kann zum Korrigieren der Freiheitsgrade für die gemittelten Signifikanztests verwendet werden. In der Tabelle mit den Tests der Effekte innerhalb der Subjekte werden korrigierte Tests angezeigt.

b.
Design: Intercept
Innersubjekt-Design: AKUSTIM+ZEIT+AKUSTIM*ZEIT

Tests der Innersubjekteffekte

Maß: MASS_1

Quelle		Quadratsumme vom Typ III	df	Mittel der Quadrate	F
AKUSTIM	Sphärizität angenommen	31,128	2	15,564	,912
	Greenhouse-Geisser	31,128	1,636	19,029	,912
	Huynh-Feldt	31,128	1,777	17,517	,912
	Untergrenze	31,128	1,000	31,128	,912
Fehler(AKUSTIM)	Sphärizität angenommen	614,254	36	17,063	
	Greenhouse-Geisser	614,254	29,444	20,862	
	Huynh-Feldt	614,254	31,987	19,203	
	Untergrenze	614,254	18,000	34,125	
ZEIT	Sphärizität angenommen	53,826	2	26,913	1,449
	Greenhouse-Geisser	53,826	1,567	34,346	1,449
	Huynh-Feldt	53,826	1,690	31,845	1,449
	Untergrenze	53,826	1,000	53,826	1,449
Fehler(ZEIT)	Sphärizität angenommen	668,669	36	18,574	
	Greenhouse-Geisser	668,669	28,209	23,704	
	Huynh-Feldt	668,669	30,425	21,978	
	Untergrenze	668,669	18,000	37,148	
AKUSTIM * ZEIT	Sphärizität angenommen	85,702	4	21,426	1,541
	Greenhouse-Geisser	85,702	1,782	48,090	1,541
	Huynh-Feldt	85,702	1,965	43,625	1,541
	Untergrenze	85,702	1,000	85,702	1,541
Fehler(AKUSTIM* ZEIT)	Sphärizität angenommen	1000,921	72	13,902	
	Greenhouse-Geisser	1000,921	32,078	31,203	
	Huynh-Feldt	1000,921	35,361	28,306	
	Untergrenze	1000,921	18,000	55,607	

Tests der Innersubjekteffekte

Maß: MASS_1

Quelle		Signifikanz	Partielles Eta-Quadrat
AKUSTIM	Sphärizität angenommen	,411	,048
	Greenhouse-Geisser	,395	,048
	Huynh-Feldt	,401	,048
	Untergrenze	,352	,048
Fehler(AKUSTIM)	Sphärizität angenommen		
	Greenhouse-Geisser		
	Huynh-Feldt		
	Untergrenze		
ZEIT	Sphärizität angenommen	,248	,074
	Greenhouse-Geisser	,250	,074
	Huynh-Feldt	,250	,074
	Untergrenze	,244	,074
Fehler(ZEIT)	Sphärizität angenommen		
	Greenhouse-Geisser		
	Huynh-Feldt		
	Untergrenze		
AKUSTIM * ZEIT	Sphärizität angenommen	,199	,079
	Greenhouse-Geisser	,230	,079
	Huynh-Feldt	,228	,079
	Untergrenze	,230	,079
Fehler(AKUSTIM* ZEIT)	Sphärizität angenommen		
	Greenhouse-Geisser		
	Huynh-Feldt		
	Untergrenze		

Tests der Innersubjektkontraste

Maß: MASS_1

Quelle	AKUSTIM	ZEIT	Quadratsumme vom Typ III	df	Mittel der Quadrate	F
AKUSTIM	Linear		28,911	1	28,911	1,159
	Quadratisch		2,216	1	2,216	,241
Fehler(AKUSTIM)	Linear		449,076	18	24,949	
	Quadratisch		165,179	18	9,177	
ZEIT		Linear	32,491	1	32,491	1,311
		Quadratisch	21,335	1	21,335	1,725
Fehler(ZEIT)		Linear	446,003	18	24,778	
		Quadratisch	222,666	18	12,370	
AKUSTIM * ZEIT	Linear	Linear	,840	1	,840	,037
		Quadratisch	4,756	1	4,756	1,380
	Quadratisch	Linear	27,755	1	27,755	1,204
		Quadratisch	52,351	1	52,351	8,037
Fehler(AKUSTIM* ZEIT)	Linear	Linear	406,557	18	22,586	
		Quadratisch	62,054	18	3,447	
	Quadratisch	Linear	415,065	18	23,059	
		Quadratisch	117,244	18	6,514	

Tests der Innersubjektkontraste

Maß: MASS_1

Quelle	AKUSTIM	ZEIT	Signifikanz	Partielles Eta-Quadrat
AKUSTIM	Linear		,296	,060
	Quadratisch		,629	,013
Fehler(AKUSTIM)	Linear			
	Quadratisch			
ZEIT		Linear	,267	,068
		Quadratisch	,206	,087
Fehler(ZEIT)		Linear		
		Quadratisch		
AKUSTIM * ZEIT	Linear	Linear	,849	,002
		Quadratisch	,255	,071
	Quadratisch	Linear	,287	,063
		Quadratisch	,011	,309
Fehler(AKUSTIM* ZEIT)	Linear	Linear		
		Quadratisch		
	Quadratisch	Linear		
		Quadratisch		

Tests der Zwischensubjekteffekte

Maß: MASS_1
Transformierte Variable: Mittel

Quelle	Quadratsumme vom Typ III	df	Mittel der Quadrate	F	Signifikanz	Partielles Eta-Quadrat
Intercept	5800,797	1	5800,797	40,664	,000	,693
Fehler	2567,751	18	142,653			

The Pearson correlations between HRV measures *during* and *after* fairytale acoustic stimulation, and scores on scales concerning mothers' well-being – SPSS output (1-18)

Appendix 9.4.

Korrelationen (vor, während und nach der akustischen Stimulation) für HRV Maße & Fragebögen

Korrelationen (vor Mutterstimme) für HRV Maße & Fragebögen

Korrelationen

		MBN2ME	MBN2MI	MBN2VA	MBN2SA	MBN2P6
BELMSUM	Korrelation nach Pearson	-,057	-,060	,188	,149	-,108
	Signifikanz (2-seitig)	,774	,763	,339	,449	,583
	N	28	28	28	28	28
RESMSUM	Korrelation nach Pearson	-,331	-,328	-,350	-,326	-,053
	Signifikanz (2-seitig)	,085	,088	,068	,091	,789
	N	28	28	28	28	28
EKMSUM	Korrelation nach Pearson	-,057	-,057	,445*	,394*	,237
	Signifikanz (2-seitig)	,773	,774	,018	,038	,225
	N	28	28	28	28	28
SUMMT	Korrelation nach Pearson	,013	-,009	-,190	-,224	-,166
	Signifikanz (2-seitig)	,953	,967	,384	,305	,450
	N	23	23	23	23	23
AEMT	Korrelation nach Pearson	,141	,129	-,026	-,042	-,038
	Signifikanz (2-seitig)	,492	,531	,899	,840	,855
	N	26	26	26	26	26
RVMT	Korrelation nach Pearson	,014	-,010	-,143	-,148	-,113
	Signifikanz (2-seitig)	,948	,963	,515	,501	,607
	N	23	23	23	23	23
KOMMT	Korrelation nach Pearson	,104	,097	-,027	-,086	-,019
	Signifikanz (2-seitig)	,614	,639	,896	,677	,928
	N	26	26	26	26	26
EMT	Korrelation nach Pearson	,040	,019	-,199	-,192	-,112
	Signifikanz (2-seitig)	,855	,931	,362	,381	,611
	N	23	23	23	23	23
ABMT	Korrelation nach Pearson	,078	,064	-,154	-,214	-,100
	Signifikanz (2-seitig)	,706	,756	,453	,295	,627
	N	26	26	26	26	26
KMT	Korrelation nach Pearson	-,388	-,405	-,402	-,424*	-,427*
	Signifikanz (2-seitig)	,074	,062	,063	,049	,047
	N	22	22	22	22	22
WNMT	Korrelation nach Pearson	-,025	-,035	-,123	-,159	-,143
	Signifikanz (2-seitig)	,902	,865	,550	,437	,485
	N	26	26	26	26	26
SEMT	Korrelation nach Pearson	-,138	-,122	-,081	-,081	,177
	Signifikanz (2-seitig)	,531	,578	,715	,713	,419
	N	23	23	23	23	23
AMT	Korrelation nach Pearson	-,303	-,299	-,370	-,324	-,129
	Signifikanz (2-seitig)	,132	,138	,063	,106	,530
	N	26	26	26	26	26

Korrelationen

		MBN2RM	MBN2SD	MBN2RS
BELMSUM	Korrelation nach Pearson	-,062	-,039	,089
	Signifikanz (2-seitig)	,753	,842	,652
	N	28	28	28
RESMSUM	Korrelation nach Pearson	-,154	-,333	-,139
	Signifikanz (2-seitig)	,434	,083	,480
	N	28	28	28
EKMSUM	Korrelation nach Pearson	,189	,203	,355
	Signifikanz (2-seitig)	,334	,301	,064
	N	28	28	28
SUMMT	Korrelation nach Pearson	-,191	-,114	-,273
	Signifikanz (2-seitig)	,382	,604	,207
	N	23	23	23
AEMT	Korrelation nach Pearson	-,090	,032	-,098
	Signifikanz (2-seitig)	,663	,876	,633
	N	26	26	26
RVMT	Korrelation nach Pearson	-,117	-,066	-,214
	Signifikanz (2-seitig)	,595	,766	,328
	N	23	23	23
KOMMT	Korrelation nach Pearson	-,058	-,037	-,044
	Signifikanz (2-seitig)	,780	,858	,831
	N	26	26	26
EMT	Korrelation nach Pearson	-,110	-,087	-,232
	Signifikanz (2-seitig)	,617	,694	,288
	N	23	23	23
ABMT	Korrelation nach Pearson	-,156	-,144	-,145
	Signifikanz (2-seitig)	,447	,481	,480
	N	26	26	26
KMT	Korrelation nach Pearson	-,502*	-,475*	-,330
	Signifikanz (2-seitig)	,017	,025	,134
	N	22	22	22
WNMT	Korrelation nach Pearson	-,124	-,058	-,233
	Signifikanz (2-seitig)	,547	,778	,251
	N	26	26	26
SEMT	Korrelation nach Pearson	,141	,051	-,051
	Signifikanz (2-seitig)	,521	,819	,816
	N	23	23	23
AMT	Korrelation nach Pearson	-,134	-,225	-,341
	Signifikanz (2-seitig)	,515	,269	,088
	N	26	26	26

*. Die Korrelation ist auf dem Niveau von 0,05 (2-seitig) signifikant.

Korrelationen (während Mutterstimme) für HRV Maße & Fragebögen

Korrelationen

		MDN2ME	MDN2MI	MDN2VA	MDN2SA	MDN2P6
BELMSUM	Korrelation nach Pearson	-,049	-,066	,147	,041	-,156
	Signifikanz (2-seitig)	,806	,739	,455	,834	,428
	N	28	28	28	28	28
RESMSUM	Korrelation nach Pearson	-,324	-,318	-,175	-,126	-,211
	Signifikanz (2-seitig)	,093	,099	,374	,523	,281
	N	28	28	28	28	28
EKMSUM	Korrelation nach Pearson	-,005	-,003	,140	,126	-,045
	Signifikanz (2-seitig)	,980	,987	,478	,524	,822
	N	28	28	28	28	28
SUMMT	Korrelation nach Pearson	-,030	-,038	-,061	-,029	-,145
	Signifikanz (2-seitig)	,893	,864	,783	,895	,509
	N	23	23	23	23	23
AEMT	Korrelation nach Pearson	,192	,186	-,056	-,016	-,137
	Signifikanz (2-seitig)	,346	,364	,785	,939	,506
	N	26	26	26	26	26
RVMT	Korrelation nach Pearson	-,130	-,137	-,063	-,052	,023
	Signifikanz (2-seitig)	,556	,534	,776	,813	,917
	N	23	23	23	23	23
KOMMT	Korrelation nach Pearson	,007	,006	,045	,053	-,038
	Signifikanz (2-seitig)	,975	,977	,825	,797	,856
	N	26	26	26	26	26
EMT	Korrelation nach Pearson	-,050	-,058	,022	,077	,066
	Signifikanz (2-seitig)	,819	,792	,921	,728	,765
	N	23	23	23	23	23
ABMT	Korrelation nach Pearson	,042	,040	-,029	-,043	-,111
	Signifikanz (2-seitig)	,840	,847	,890	,835	,588
	N	26	26	26	26	26
KMT	Korrelation nach Pearson	-,357	-,385	-,171	-,227	-,283
	Signifikanz (2-seitig)	,103	,077	,447	,310	,202
	N	22	22	22	22	22
WNMT	Korrelation nach Pearson	-,048	-,047	-,041	-,004	-,224
	Signifikanz (2-seitig)	,815	,820	,844	,984	,272
	N	26	26	26	26	26
SEMT	Korrelation nach Pearson	-,087	-,073	-,210	-,269	,038
	Signifikanz (2-seitig)	,692	,740	,337	,215	,863
	N	23	23	23	23	23
AMT	Korrelation nach Pearson	-,329	-,331	-,197	-,197	-,029
	Signifikanz (2-seitig)	,101	,099	,336	,334	,888
	N	26	26	26	26	26

Korrelationen

		MDN2RM	MDN2SD	MDN2RS
BELMSUM	Korrelation nach Pearson	-,083	-,025	,180
	Signifikanz (2-seitig)	,675	,900	,360
	N	28	28	28
RESMSUM	Korrelation nach Pearson	-,285	-,320	-,197
	Signifikanz (2-seitig)	,141	,096	,315
	N	28	28	28
EKMSUM	Korrelation nach Pearson	,032	,051	,222
	Signifikanz (2-seitig)	,871	,796	,257
	N	28	28	28
SUMMT	Korrelation nach Pearson	-,152	-,146	-,044
	Signifikanz (2-seitig)	,488	,505	,841
	N	23	23	23
AEMT	Korrelation nach Pearson	-,085	-,106	,017
	Signifikanz (2-seitig)	,678	,606	,935
	N	26	26	26
RVMT	Korrelation nach Pearson	-,087	-,114	-,052
	Signifikanz (2-seitig)	,694	,604	,814
	N	23	23	23
KOMMT	Korrelation nach Pearson	-,041	-,007	,046
	Signifikanz (2-seitig)	,843	,972	,824
	N	26	26	26
EMT	Korrelation nach Pearson	-,010	-,012	,038
	Signifikanz (2-seitig)	,964	,956	,864
	N	23	23	23
ABMT	Korrelation nach Pearson	-,114	-,100	-,041
	Signifikanz (2-seitig)	,580	,626	,844
	N	26	26	26
KMT	Korrelation nach Pearson	-,403	-,388	-,173
	Signifikanz (2-seitig)	,063	,074	,440
	N	22	22	22
WNMT	Korrelation nach Pearson	-,128	-,070	-,022
	Signifikanz (2-seitig)	,532	,733	,914
	N	26	26	26
SEMT	Korrelation nach Pearson	,008	-,082	-,290
	Signifikanz (2-seitig)	,971	,710	,179
	N	23	23	23
AMT	Korrelation nach Pearson	-,171	-,213	-,284
	Signifikanz (2-seitig)	,404	,296	,160
	N	26	26	26

Korrelationen (nach Mutterstimme) für HRV Maße & Fragebögen

Korrelationen

		MAN2ME	MAN2MI	MAN2VA	MAN2SA	MAN2P6
BELMSUM	Korrelation nach Pearson	-,085	-,079	,408*	,392*	,057
	Signifikanz (2-seitig)	,666	,690	,031	,039	,772
	N	28	28	28	28	28
RESMSUM	Korrelation nach Pearson	-,263	-,268	-,160	-,135	-,135
	Signifikanz (2-seitig)	,176	,168	,415	,495	,494
	N	28	28	28	28	28
EKMSUM	Korrelation nach Pearson	-,064	-,044	,358	,355	,234
	Signifikanz (2-seitig)	,748	,825	,061	,064	,231
	N	28	28	28	28	28
SUMMT	Korrelation nach Pearson	-,074	-,088	-,152	-,164	-,136
	Signifikanz (2-seitig)	,737	,691	,488	,454	,537
	N	23	23	23	23	23
AEMT	Korrelation nach Pearson	,147	,145	-,217	-,269	-,048
	Signifikanz (2-seitig)	,474	,480	,288	,184	,816
	N	26	26	26	26	26
RVMT	Korrelation nach Pearson	-,141	-,149	-,173	-,190	-,194
	Signifikanz (2-seitig)	,522	,498	,429	,385	,376
	N	23	23	23	23	23
KOMMT	Korrelation nach Pearson	-,120	-,121	,035	,038	,065
	Signifikanz (2-seitig)	,560	,557	,867	,854	,752
	N	26	26	26	26	26
EMT	Korrelation nach Pearson	-,075	-,093	-,179	-,198	-,179
	Signifikanz (2-seitig)	,735	,673	,415	,366	,414
	N	23	23	23	23	23
ABMT	Korrelation nach Pearson	-,089	-,094	-,071	-,101	-,005
	Signifikanz (2-seitig)	,667	,648	,731	,624	,981
	N	26	26	26	26	26
KMT	Korrelation nach Pearson	-,325	-,335	-,090	-,067	-,340
	Signifikanz (2-seitig)	,140	,128	,689	,767	,122
	N	22	22	22	22	22
WNMT	Korrelation nach Pearson	-,134	-,151	,000	,010	-,016
	Signifikanz (2-seitig)	,513	,462	1,000	,963	,939
	N	26	26	26	26	26
SEMT	Korrelation nach Pearson	-,060	-,054	-,091	-,059	,161
	Signifikanz (2-seitig)	,787	,806	,681	,788	,463
	N	23	23	23	23	23
AMT	Korrelation nach Pearson	-,210	-,221	-,163	-,097	-,143
	Signifikanz (2-seitig)	,304	,279	,427	,639	,486
	N	26	26	26	26	26

Korrelationen

		MAN2RM	MAN2SD	MAN2RS
BELMSUM	Korrelation nach Pearson	,090	,230	,334
	Signifikanz (2-seitig)	,649	,238	,083
	N	28	28	28
RESMSUM	Korrelation nach Pearson	-,128	-,007	-,220
	Signifikanz (2-seitig)	,517	,972	,261
	N	28	28	28
EKMSUM	Korrelation nach Pearson	,277	,522**	,166
	Signifikanz (2-seitig)	,154	,004	,399
	N	28	28	28
SUMMT	Korrelation nach Pearson	-,189	-,126	-,097
	Signifikanz (2-seitig)	,389	,566	,660
	N	23	23	23
AEMT	Korrelation nach Pearson	-,127	-,129	-,130
	Signifikanz (2-seitig)	,537	,529	,528
	N	26	26	26
RVMT	Korrelation nach Pearson	-,248	-,153	-,104
	Signifikanz (2-seitig)	,254	,485	,636
	N	23	23	23
KOMMT	Korrelation nach Pearson	,012	,009	,029
	Signifikanz (2-seitig)	,955	,965	,889
	N	26	26	26
EMT	Korrelation nach Pearson	-,229	-,226	-,069
	Signifikanz (2-seitig)	,293	,300	,755
	N	23	23	23
ABMT	Korrelation nach Pearson	-,102	-,137	-,049
	Signifikanz (2-seitig)	,620	,506	,813
	N	26	26	26
KMT	Korrelation nach Pearson	-,369	-,050	-,060
	Signifikanz (2-seitig)	,091	,824	,792
	N	22	22	22
WNMT	Korrelation nach Pearson	-,027	,092	-,050
	Signifikanz (2-seitig)	,897	,653	,808
	N	26	26	26
SEMT	Korrelation nach Pearson	,168	,084	-,171
	Signifikanz (2-seitig)	,443	,704	,435
	N	23	23	23
AMT	Korrelation nach Pearson	-,093	,003	-,182
	Signifikanz (2-seitig)	,651	,987	,373
	N	26	26	26

*. Die Korrelation ist auf dem Niveau von 0,05 (2-seitig) signifikant.

**. Die Korrelation ist auf dem Niveau von 0,01 (2-seitig) signifikant.

Korrelationen (vor Lullaby Musik) für HRV Maße & Fragebögen

Korrelationen

		LBN2ME	LBN2MI	LBN2VA	LBN2SA	LBN2P6
BELMSUM	Korrelation nach Pearson	-,007	,003	,322	,295	,021
	Signifikanz (2-seitig)	,972	,989	,101	,136	,919
	N	27	27	27	27	27
RESMSUM	Korrelation nach Pearson	-,160	-,174	-,206	-,182	,060
	Signifikanz (2-seitig)	,426	,387	,302	,364	,765
	N	27	27	27	27	27
EKMSUM	Korrelation nach Pearson	-,048	-,049	,132	,035	,228
	Signifikanz (2-seitig)	,811	,809	,510	,861	,253
	N	27	27	27	27	27
SUMMT	Korrelation nach Pearson	-,145	-,144	-,135	-,149	-,234
	Signifikanz (2-seitig)	,519	,523	,548	,507	,294
	N	22	22	22	22	22
AEMT	Korrelation nach Pearson	-,135	-,126	-,157	-,190	-,103
	Signifikanz (2-seitig)	,519	,547	,454	,363	,624
	N	25	25	25	25	25
RVMT	Korrelation nach Pearson	-,211	-,209	-,139	-,137	-,177
	Signifikanz (2-seitig)	,346	,351	,538	,543	,431
	N	22	22	22	22	22
KOMMT	Korrelation nach Pearson	-,008	-,003	-,015	-,036	-,089
	Signifikanz (2-seitig)	,970	,989	,944	,866	,674
	N	25	25	25	25	25
EMT	Korrelation nach Pearson	-,089	-,086	-,065	-,050	-,130
	Signifikanz (2-seitig)	,694	,703	,774	,825	,563
	N	22	22	22	22	22
ABMT	Korrelation nach Pearson	-,048	-,054	-,113	-,177	-,183
	Signifikanz (2-seitig)	,819	,799	,589	,396	,380
	N	25	25	25	25	25
KMT	Korrelation nach Pearson	-,325	-,314	-,126	-,170	-,438*
	Signifikanz (2-seitig)	,150	,166	,588	,460	,047
	N	21	21	21	21	21
WNMT	Korrelation nach Pearson	-,077	-,079	-,045	-,041	-,163
	Signifikanz (2-seitig)	,715	,709	,830	,845	,435
	N	25	25	25	25	25
SEMT	Korrelation nach Pearson	,009	,014	-,119	-,066	,197
	Signifikanz (2-seitig)	,968	,949	,599	,769	,380
	N	22	22	22	22	22
AMT	Korrelation nach Pearson	-,111	-,104	-,114	,008	-,063
	Signifikanz (2-seitig)	,597	,621	,589	,971	,763
	N	25	25	25	25	25

Korrelationen

		LBN2RM	LBN2SD	LBN2RS
BELMSUM	Korrelation nach Pearson	-,026	,153	,387*
	Signifikanz (2-seitig)	,898	,446	,046
	N	27	27	27
RESMSUM	Korrelation nach Pearson	,109	,075	-,184
	Signifikanz (2-seitig)	,587	,710	,359
	N	27	27	27
EKMSUM	Korrelation nach Pearson	,045	-,072	-,001
	Signifikanz (2-seitig)	,823	,723	,996
	N	27	27	27
SUMMT	Korrelation nach Pearson	-,353	-,191	-,066
	Signifikanz (2-seitig)	,107	,395	,771
	N	22	22	22
AEMT	Korrelation nach Pearson	-,265	-,191	-,159
	Signifikanz (2-seitig)	,200	,361	,447
	N	25	25	25
RVMT	Korrelation nach Pearson	-,318	-,169	-,048
	Signifikanz (2-seitig)	,150	,452	,833
	N	22	22	22
KOMMT	Korrelation nach Pearson	-,159	-,014	,016
	Signifikanz (2-seitig)	,448	,949	,940
	N	25	25	25
EMT	Korrelation nach Pearson	-,226	-,058	,052
	Signifikanz (2-seitig)	,312	,798	,818
	N	22	22	22
ABMT	Korrelation nach Pearson	-,230	-,201	-,152
	Signifikanz (2-seitig)	,268	,335	,469
	N	25	25	25
KMT	Korrelation nach Pearson	-,536*	-,179	,002
	Signifikanz (2-seitig)	,012	,437	,995
	N	21	21	21
WNMT	Korrelation nach Pearson	-,235	-,200	-,051
	Signifikanz (2-seitig)	,258	,338	,810
	N	25	25	25
SEMT	Korrelation nach Pearson	,277	,168	-,164
	Signifikanz (2-seitig)	,212	,455	,466
	N	22	22	22
AMT	Korrelation nach Pearson	,038	,200	,057
	Signifikanz (2-seitig)	,857	,338	,788
	N	25	25	25

*. Die Korrelation ist auf dem Niveau von 0,05 (2-seitig) signifikant.

Korrelationen (während Lullaby Musik) für HRV Maße & Fragebögen

Korrelationen

		LDN2ME	LDN2MI	LDN2VA	LDN2SA	LDN2P6
BELMSUM	Korrelation nach Pearson	-,099	-,017	,312	,259	,059
	Signifikanz (2-seitig)	,622	,932	,113	,192	,771
	N	27	27	27	27	27
RESMSUM	Korrelation nach Pearson	-,195	-,244	-,228	-,223	-,085
	Signifikanz (2-seitig)	,330	,220	,252	,264	,672
	N	27	27	27	27	27
EKMSUM	Korrelation nach Pearson	-,064	-,030	,216	,169	,142
	Signifikanz (2-seitig)	,750	,884	,278	,400	,480
	N	27	27	27	27	27
SUMMT	Korrelation nach Pearson	-,042	-,014	-,016	-,017	,068
	Signifikanz (2-seitig)	,854	,952	,942	,939	,764
	N	22	22	22	22	22
AEMT	Korrelation nach Pearson	,030	,035	,033	,020	,163
	Signifikanz (2-seitig)	,886	,869	,875	,923	,437
	N	25	25	25	25	25
RVMT	Korrelation nach Pearson	-,168	-,107	,017	,008	,233
	Signifikanz (2-seitig)	,456	,635	,939	,974	,297
	N	22	22	22	22	22
KOMMT	Korrelation nach Pearson	-,028	-,035	-,112	-,110	,020
	Signifikanz (2-seitig)	,893	,869	,595	,599	,926
	N	25	25	25	25	25
EMT	Korrelation nach Pearson	-,069	-,020	,172	,199	,310
	Signifikanz (2-seitig)	,761	,931	,444	,376	,160
	N	22	22	22	22	22
ABMT	Korrelation nach Pearson	-,025	-,027	-,206	-,219	-,068
	Signifikanz (2-seitig)	,904	,900	,322	,292	,748
	N	25	25	25	25	25
KMT	Korrelation nach Pearson	-,237	-,205	-,017	-,039	-,102
	Signifikanz (2-seitig)	,301	,373	,941	,868	,661
	N	21	21	21	21	21
WNMT	Korrelation nach Pearson	,037	,061	,022	,036	-,006
	Signifikanz (2-seitig)	,860	,772	,918	,865	,979
	N	25	25	25	25	25
SEMT	Korrelation nach Pearson	,045	-,044	-,242	-,231	-,162
	Signifikanz (2-seitig)	,841	,847	,277	,302	,470
	N	22	22	22	22	22
AMT	Korrelation nach Pearson	-,073	-,109	-,048	,001	-,056
	Signifikanz (2-seitig)	,729	,605	,821	,995	,789
	N	25	25	25	25	25

Korrelationen

		LDN2RM	LDN2SD	LDN2RS
BELMSUM	Korrelation nach Pearson	,059	,291	,394*
	Signifikanz (2-seitig)	,768	,141	,042
	N	27	27	27
RESMSUM	Korrelation nach Pearson	-,117	-,266	-,254
	Signifikanz (2-seitig)	,562	,179	,201
	N	27	27	27
EKMSUM	Korrelation nach Pearson	,156	,183	,144
	Signifikanz (2-seitig)	,437	,360	,473
	N	27	27	27
SUMMT	Korrelation nach Pearson	-,052	,121	,172
	Signifikanz (2-seitig)	,819	,592	,444
	N	22	22	22
AEMT	Korrelation nach Pearson	,089	,184	,143
	Signifikanz (2-seitig)	,671	,379	,496
	N	25	25	25
RVMT	Korrelation nach Pearson	,004	,199	,215
	Signifikanz (2-seitig)	,985	,375	,336
	N	22	22	22
KOMMT	Korrelation nach Pearson	-,047	-,012	,089
	Signifikanz (2-seitig)	,823	,954	,671
	N	25	25	25
EMT	Korrelation nach Pearson	,126	,317	,377
	Signifikanz (2-seitig)	,577	,151	,083
	N	22	22	22
ABMT	Korrelation nach Pearson	-,113	-,071	-,004
	Signifikanz (2-seitig)	,590	,734	,984
	N	25	25	25
KMT	Korrelation nach Pearson	-,255	,039	,158
	Signifikanz (2-seitig)	,265	,866	,493
	N	21	21	21
WNMT	Korrelation nach Pearson	-,041	,117	,181
	Signifikanz (2-seitig)	,846	,578	,388
	N	25	25	25
SEMT	Korrelation nach Pearson	-,062	-,328	-,480*
	Signifikanz (2-seitig)	,783	,137	,024
	N	22	22	22
AMT	Korrelation nach Pearson	-,092	-,112	-,129
	Signifikanz (2-seitig)	,663	,596	,538
	N	25	25	25

*. Die Korrelation ist auf dem Niveau von 0,05 (2-seitig) signifikant.

Korrelationen (nach lullaby Musik) für HRV Maße & Fragebögen

Korrelationen

		LAN2ME	LAN2MI	LAN2VA	LAN2SA	LAN2P6
BELMSUM	Korrelation nach Pearson	-,178	-,158	-,024	-,074	,138
	Signifikanz (2-seitig)	,374	,431	,907	,713	,494
	N	27	27	27	27	27
RESMSUM	Korrelation nach Pearson	-,103	-,118	-,043	-,035	,106
	Signifikanz (2-seitig)	,609	,557	,831	,863	,597
	N	27	27	27	27	27
EKMSUM	Korrelation nach Pearson	-,099	-,120	,171	,143	,249
	Signifikanz (2-seitig)	,624	,552	,395	,478	,210
	N	27	27	27	27	27
SUMMT	Korrelation nach Pearson	-,056	-,013	,066	,083	-,070
	Signifikanz (2-seitig)	,805	,953	,770	,713	,755
	N	22	22	22	22	22
AEMT	Korrelation nach Pearson	,073	,096	,205	,209	,035
	Signifikanz (2-seitig)	,728	,648	,324	,317	,867
	N	25	25	25	25	25
RVMT	Korrelation nach Pearson	-,126	-,085	,028	,033	,023
	Signifikanz (2-seitig)	,576	,706	,900	,885	,919
	N	22	22	22	22	22
KOMMT	Korrelation nach Pearson	-,101	-,089	,097	,083	-,100
	Signifikanz (2-seitig)	,631	,674	,645	,695	,633
	N	25	25	25	25	25
EMT	Korrelation nach Pearson	-,065	-,009	,068	,105	,087
	Signifikanz (2-seitig)	,773	,967	,765	,643	,700
	N	22	22	22	22	22
ABMT	Korrelation nach Pearson	-,040	-,029	,017	-,009	-,147
	Signifikanz (2-seitig)	,851	,891	,936	,967	,483
	N	25	25	25	25	25
KMT	Korrelation nach Pearson	-,332	-,284	-,064	-,088	-,174
	Signifikanz (2-seitig)	,142	,213	,783	,704	,450
	N	21	21	21	21	21
WNMT	Korrelation nach Pearson	-,092	-,063	,025	,053	,042
	Signifikanz (2-seitig)	,663	,763	,905	,802	,843
	N	25	25	25	25	25
SEMT	Korrelation nach Pearson	,105	,076	-,205	-,226	-,018
	Signifikanz (2-seitig)	,643	,737	,361	,312	,936
	N	22	22	22	22	22
AMT	Korrelation nach Pearson	-,138	-,113	-,267	-,234	-,028
	Signifikanz (2-seitig)	,512	,592	,197	,260	,893
	N	25	25	25	25	25

Korrelationen

		LAN2RM	LAN2SD	LAN2RS
BELMSUM	Korrelation nach Pearson	-,002	-,097	,055
	Signifikanz (2-seitig)	,990	,629	,784
	N	27	27	27
RESMSUM	Korrelation nach Pearson	,172	,123	-,106
	Signifikanz (2-seitig)	,391	,542	,599
	N	27	27	27
EKMSUM	Korrelation nach Pearson	,240	,236	,065
	Signifikanz (2-seitig)	,229	,237	,747
	N	27	27	27
SUMMT	Korrelation nach Pearson	-,140	,065	,193
	Signifikanz (2-seitig)	,535	,773	,389
	N	22	22	22
AEMT	Korrelation nach Pearson	-,004	,214	,137
	Signifikanz (2-seitig)	,983	,305	,513
	N	25	25	25
RVMT	Korrelation nach Pearson	-,110	,137	,110
	Signifikanz (2-seitig)	,625	,542	,625
	N	22	22	22
KOMMT	Korrelation nach Pearson	-,140	,057	,092
	Signifikanz (2-seitig)	,504	,788	,663
	N	25	25	25
EMT	Korrelation nach Pearson	-,013	,164	,174
	Signifikanz (2-seitig)	,955	,466	,440
	N	22	22	22
ABMT	Korrelation nach Pearson	-,199	-,070	-,001
	Signifikanz (2-seitig)	,340	,739	,997
	N	25	25	25
KMT	Korrelation nach Pearson	-,344	-,127	-,011
	Signifikanz (2-seitig)	,127	,582	,964
	N	21	21	21
WNMT	Korrelation nach Pearson	,010	,095	,212
	Signifikanz (2-seitig)	,961	,652	,310
	N	25	25	25
SEMT	Korrelation nach Pearson	,031	-,231	-,354
	Signifikanz (2-seitig)	,891	,302	,106
	N	22	22	22
AMT	Korrelation nach Pearson	-,083	-,178	-,109
	Signifikanz (2-seitig)	,693	,396	,604
	N	25	25	25

Korrelationen (vor Kontrolluntersuchung) für HRV Maße & Fragebögen

Korrelationen

		CBN2ME	CBN2MI	CBN2VA	CBN2SA	CBN2P6
BELMSUM	Korrelation nach Pearson	,147	,127	-,173	-,152	-,133
	Signifikanz (2-seitig)	,549	,605	,479	,534	,589
	N	19	19	19	19	19
RESMSUM	Korrelation nach Pearson	-,364	-,378	-,064	-,113	-,274
	Signifikanz (2-seitig)	,125	,111	,796	,646	,257
	N	19	19	19	19	19
EKMSUM	Korrelation nach Pearson	,297	,275	-,058	,010	-,205
	Signifikanz (2-seitig)	,204	,240	,809	,967	,386
	N	20	20	20	20	20
SUMMT	Korrelation nach Pearson	-,177	-,151	-,114	-,130	-,262
	Signifikanz (2-seitig)	,498	,564	,664	,619	,309
	N	17	17	17	17	17
AEMT	Korrelation nach Pearson	,018	,033	-,036	-,033	-,300
	Signifikanz (2-seitig)	,944	,901	,892	,901	,242
	N	17	17	17	17	17
RVMT	Korrelation nach Pearson	-,347	-,341	-,335	-,378	-,295
	Signifikanz (2-seitig)	,172	,180	,189	,134	,251
	N	17	17	17	17	17
KOMMT	Korrelation nach Pearson	,020	,066	,046	,041	-,214
	Signifikanz (2-seitig)	,940	,801	,861	,875	,409
	N	17	17	17	17	17
EMT	Korrelation nach Pearson	-,274	-,262	-,280	-,314	-,294
	Signifikanz (2-seitig)	,287	,309	,277	,219	,252
	N	17	17	17	17	17
ABMT	Korrelation nach Pearson	-,164	-,144	-,146	-,144	-,222
	Signifikanz (2-seitig)	,530	,582	,576	,581	,392
	N	17	17	17	17	17
KMT	Korrelation nach Pearson	-,405	-,381	-,177	-,193	-,254
	Signifikanz (2-seitig)	,107	,131	,496	,457	,325
	N	17	17	17	17	17
WNMT	Korrelation nach Pearson	-,063	-,027	,159	,142	-,005
	Signifikanz (2-seitig)	,809	,919	,543	,588	,983
	N	17	17	17	17	17
SEMT	Korrelation nach Pearson	-,007	,002	,194	,187	,249
	Signifikanz (2-seitig)	,977	,993	,455	,471	,336
	N	17	17	17	17	17
AMT	Korrelation nach Pearson	-,132	-,088	,272	,212	,111
	Signifikanz (2-seitig)	,613	,736	,291	,414	,671
	N	17	17	17	17	17

Korrelationen

		CBN2RM	CBN2SD	CBN2RS
BELMSUM	Korrelation nach Pearson	-,045	-,111	,174
	Signifikanz (2-seitig)	,855	,651	,475
	N	19	19	19
RESMSUM	Korrelation nach Pearson	-,239	-,350	-,250
	Signifikanz (2-seitig)	,325	,141	,302
	N	19	19	19
EKMSUM	Korrelation nach Pearson	-,085	-,145	,124
	Signifikanz (2-seitig)	,723	,543	,603
	N	20	20	20
SUMMT	Korrelation nach Pearson	-,126	-,072	-,005
	Signifikanz (2-seitig)	,631	,784	,986
	N	17	17	17
AEMT	Korrelation nach Pearson	-,162	-,047	,024
	Signifikanz (2-seitig)	,535	,859	,928
	N	17	17	17
RVMT	Korrelation nach Pearson	-,199	-,229	-,124
	Signifikanz (2-seitig)	,443	,376	,636
	N	17	17	17
KOMMT	Korrelation nach Pearson	,000	,055	,128
	Signifikanz (2-seitig)	,999	,833	,625
	N	17	17	17
EMT	Korrelation nach Pearson	-,213	-,174	-,172
	Signifikanz (2-seitig)	,412	,504	,509
	N	17	17	17
ABMT	Korrelation nach Pearson	-,109	-,109	,012
	Signifikanz (2-seitig)	,678	,677	,963
	N	17	17	17
KMT	Korrelation nach Pearson	-,216	-,159	-,037
	Signifikanz (2-seitig)	,405	,542	,887
	N	17	17	17
WNMT	Korrelation nach Pearson	,101	,163	,073
	Signifikanz (2-seitig)	,700	,531	,779
	N	17	17	17
SEMT	Korrelation nach Pearson	,098	,054	-,152
	Signifikanz (2-seitig)	,708	,838	,560
	N	17	17	17
AMT	Korrelation nach Pearson	,029	,133	-,133
	Signifikanz (2-seitig)	,913	,611	,612
	N	17	17	17

Korrelationen (während Kontrolluntersuchung) für HRV Maße & Fragebögen

Korrelationen

		CDN2ME	CDN2MI	CDN2VA	CDN2SA	CDN2P6
BELMSUM	Korrelation nach Pearson	-,096	-,029	,334	,217	,208
	Signifikanz (2-seitig)	,694	,905	,162	,372	,394
	N	19	19	19	19	19
RESMSUM	Korrelation nach Pearson	-,347	-,373	-,323	-,322	-,319
	Signifikanz (2-seitig)	,145	,116	,177	,178	,183
	N	19	19	19	19	19
EKMSUM	Korrelation nach Pearson	-,091	-,027	,291	,265	,071
	Signifikanz (2-seitig)	,703	,910	,214	,259	,767
	N	20	20	20	20	20
SUMMT	Korrelation nach Pearson	-,027	-,057	,003	,008	,209
	Signifikanz (2-seitig)	,917	,829	,992	,977	,421
	N	17	17	17	17	17
AEMT	Korrelation nach Pearson	,249	,198	-,045	,014	,143
	Signifikanz (2-seitig)	,335	,447	,864	,958	,584
	N	17	17	17	17	17
RVMT	Korrelation nach Pearson	-,179	-,197	-,109	-,162	,137
	Signifikanz (2-seitig)	,492	,448	,678	,534	,601
	N	17	17	17	17	17
KOMMT	Korrelation nach Pearson	,064	,060	,159	,186	,309
	Signifikanz (2-seitig)	,806	,818	,543	,474	,228
	N	17	17	17	17	17
EMT	Korrelation nach Pearson	-,054	-,081	-,051	-,068	,096
	Signifikanz (2-seitig)	,838	,756	,845	,796	,715
	N	17	17	17	17	17
ABMT	Korrelation nach Pearson	-,100	-,111	,022	,012	,222
	Signifikanz (2-seitig)	,702	,671	,934	,965	,391
	N	17	17	17	17	17
KMT	Korrelation nach Pearson	-,222	-,254	-,041	-,068	,145
	Signifikanz (2-seitig)	,392	,325	,877	,795	,580
	N	17	17	17	17	17
WNMT	Korrelation nach Pearson	-,109	-,136	,068	,083	,175
	Signifikanz (2-seitig)	,677	,603	,796	,753	,502
	N	17	17	17	17	17
SEMT	Korrelation nach Pearson	,009	-,011	-,294	-,239	-,341
	Signifikanz (2-seitig)	,971	,968	,252	,357	,180
	N	17	17	17	17	17
AMT	Korrelation nach Pearson	,025	-,024	-,206	-,138	-,234
	Signifikanz (2-seitig)	,923	,926	,428	,597	,365
	N	17	17	17	17	17

Korrelationen

		CDN2RM	CDN2SD	CDN2RS
BELMSUM	Korrelation nach Pearson	,197	,001	,339
	Signifikanz (2-seitig)	,418	,996	,155
	N	19	19	19
RESMSUM	Korrelation nach Pearson	-,339	-,387	-,352
	Signifikanz (2-seitig)	,156	,102	,140
	N	19	19	19
EKMSUM	Korrelation nach Pearson	-,011	-,068	,207
	Signifikanz (2-seitig)	,963	,776	,380
	N	20	20	20
SUMMT	Korrelation nach Pearson	,105	,119	,099
	Signifikanz (2-seitig)	,689	,649	,704
	N	17	17	17
AEMT	Korrelation nach Pearson	,021	,136	,011
	Signifikanz (2-seitig)	,937	,603	,967
	N	17	17	17
RVMT	Korrelation nach Pearson	,041	-,007	,026
	Signifikanz (2-seitig)	,876	,979	,920
	N	17	17	17
KOMMT	Korrelation nach Pearson	,187	,219	,250
	Signifikanz (2-seitig)	,472	,399	,333
	N	17	17	17
EMT	Korrelation nach Pearson	,073	,025	,096
	Signifikanz (2-seitig)	,780	,924	,715
	N	17	17	17
ABMT	Korrelation nach Pearson	,071	,099	,077
	Signifikanz (2-seitig)	,786	,705	,769
	N	17	17	17
KMT	Korrelation nach Pearson	,056	,027	,025
	Signifikanz (2-seitig)	,830	,917	,925
	N	17	17	17
WNMT	Korrelation nach Pearson	,162	,139	,106
	Signifikanz (2-seitig)	,536	,596	,685
	N	17	17	17
SEMT	Korrelation nach Pearson	-,276	-,256	-,376
	Signifikanz (2-seitig)	,284	,320	,137
	N	17	17	17
AMT	Korrelation nach Pearson	-,099	-,142	-,183
	Signifikanz (2-seitig)	,705	,587	,481
	N	17	17	17

Korrelationen (nach Kontrolluntersuchung) für HRV Maße & Fragebögen

Korrelationen

		CAN2ME	CAN2MI	CAN2VA	CAN2SA	CAN2P6
BELMSUM	Korrelation nach Pearson	-,038	-,025	,197	,252	-,094
	Signifikanz (2-seitig)	,879	,918	,418	,299	,702
	N	19	19	19	19	19
RESMSUM	Korrelation nach Pearson	-,428	-,373	-,350	-,330	,131
	Signifikanz (2-seitig)	,068	,116	,142	,167	,593
	N	19	19	19	19	19
EKMSUM	Korrelation nach Pearson	,024	,061	,221	,284	-,193
	Signifikanz (2-seitig)	,921	,797	,349	,226	,415
	N	20	20	20	20	20
SUMMT	Korrelation nach Pearson	,170	,166	-,263	-,289	,062
	Signifikanz (2-seitig)	,514	,525	,308	,260	,812
	N	17	17	17	17	17
AEMT	Korrelation nach Pearson	,454	,440	-,246	-,234	,068
	Signifikanz (2-seitig)	,067	,077	,342	,366	,795
	N	17	17	17	17	17
RVMT	Korrelation nach Pearson	-,057	-,056	-,323	-,370	-,006
	Signifikanz (2-seitig)	,827	,830	,206	,144	,983
	N	17	17	17	17	17
KOMMT	Korrelation nach Pearson	,256	,264	-,084	-,107	,076
	Signifikanz (2-seitig)	,321	,306	,748	,682	,772
	N	17	17	17	17	17
EMT	Korrelation nach Pearson	,082	,080	-,364	-,379	-,045
	Signifikanz (2-seitig)	,754	,761	,151	,134	,864
	N	17	17	17	17	17
ABMT	Korrelation nach Pearson	,109	,110	-,115	-,149	,102
	Signifikanz (2-seitig)	,676	,674	,660	,567	,696
	N	17	17	17	17	17
KMT	Korrelation nach Pearson	-,071	-,077	-,331	-,374	-,063
	Signifikanz (2-seitig)	,788	,768	,195	,139	,810
	N	17	17	17	17	17
WNMT	Korrelation nach Pearson	,062	,052	-,182	-,215	,164
	Signifikanz (2-seitig)	,812	,843	,484	,407	,529
	N	17	17	17	17	17
SEMT	Korrelation nach Pearson	-,120	-,123	,040	,042	,080
	Signifikanz (2-seitig)	,645	,639	,877	,873	,761
	N	17	17	17	17	17
AMT	Korrelation nach Pearson	-,094	-,099	-,296	-,305	-,081
	Signifikanz (2-seitig)	,720	,704	,249	,233	,758
	N	17	17	17	17	17

Korrelationen

		CAN2RM	CAN2SD	CAN2RS
BELMSUM	Korrelation nach Pearson	,204	,044	,565*
	Signifikanz (2-seitig)	,401	,858	,012
	N	19	19	19
RESMSUM	Korrelation nach Pearson	-,165	-,050	-,213
	Signifikanz (2-seitig)	,500	,838	,382
	N	19	19	19
EKMSUM	Korrelation nach Pearson	,148	,018	,527*
	Signifikanz (2-seitig)	,534	,939	,017
	N	20	20	20
SUMMT	Korrelation nach Pearson	-,054	-,020	-,136
	Signifikanz (2-seitig)	,836	,938	,602
	N	17	17	17
AEMT	Korrelation nach Pearson	-,039	,113	-,242
	Signifikanz (2-seitig)	,882	,667	,349
	N	17	17	17
RVMT	Korrelation nach Pearson	-,132	-,124	-,165
	Signifikanz (2-seitig)	,613	,634	,528
	N	17	17	17
KOMMT	Korrelation nach Pearson	,056	,002	,040
	Signifikanz (2-seitig)	,832	,994	,878
	N	17	17	17
EMT	Korrelation nach Pearson	-,127	-,154	-,183
	Signifikanz (2-seitig)	,627	,554	,483
	N	17	17	17
ABMT	Korrelation nach Pearson	-,012	,039	-,045
	Signifikanz (2-seitig)	,962	,882	,865
	N	17	17	17
KMT	Korrelation nach Pearson	-,196	-,138	-,161
	Signifikanz (2-seitig)	,451	,598	,536
	N	17	17	17
WNMT	Korrelation nach Pearson	,039	,004	-,060
	Signifikanz (2-seitig)	,881	,988	,820
	N	17	17	17
SEMT	Korrelation nach Pearson	-,060	-,030	-,245
	Signifikanz (2-seitig)	,820	,908	,343
	N	17	17	17
AMT	Korrelation nach Pearson	-,232	-,273	-,367
	Signifikanz (2-seitig)	,371	,288	,147
	N	17	17	17

*. Die Korrelation ist auf dem Niveau von 0,05 (2-seitig) signifikant.

LEBENSLAUF (KURZ)

PERSONALIEN

Name und Vorname:	Djordjevic, Dragana
Geburtsdatum:	15.02.1969
Geburtsort:	Niš, Serbien
Familienstand:	ledig
Vater:	Radosav Djordjevic
Mutter:	Dušica Djordjevic

SCHULISCHER WERDEGANG

1975-1979	Acht-jährige Grundschule „21. Mai“, Niš
1989-1983	Acht-jährige Grundschule „Ratko Vukicevic“, Niš
1983-1985	Gymnasium „9. Mai“, Niš
1985-1987	Gymnasium „Svetozar Markovic“, Niš
Juni 1987	Abitur

UNIVERSTÄRER WERDEGANG

WS 1987/1988	Beginn des Studiums der Medizin an der Universität Niš
25. Dezember 1992	Ende des Studiums der Medizin an der Universität Niš
1992- 1993	Praktisches Jahr
Staatsexamen	28. Dezember 1993, Ministerium für Gesundheit der Republik Serbien

BERUFLICHER WERDEGANG

1994-1999	Fachausbildung in Kinder- und Jugendmedizin an der Medizinischen Fakultät der Universität in Niš
seit 15. Nov. 1999	Fachärztin für Kinderheilkunde

CURRICULUM VITAE

Dragana Djordjevic

Personalangaben:

Geburtstag und –ort:	15. Februar 1969 Niš, Serbien
Familienstand:	ledig
Vater:	Prof. Dr. Radosav Djordjevic
Mutter:	Mag. Dušica Djordjevic
Sprachkenntnisse:	Englisch, Deutsch, Französisch, Serbisch
Hobbys:	Tanzen, Lesen, Reisen, Ski-fahren, Schwimmen
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E-Mail:	d_djordjevic@yahoo.com, Dragana.Djordjevic@med.uni-heidelberg.de

Bildungsgang:

04/2005-10/2005
Fellowship am Hanse-Wissenschaftskolleg (Hanse Institut for Advanced Study), Delmenhorst, zur Fortsetzung des Forschungsprojekts „Premature Born Infant's Reaction to the Mother's Voice in Comparison with Reaction to Music"

Seit 04/2004
Promotionsvorhaben (Promotionsstudiengang im Fachbereich Psychosomatik) an der Medizinischen Fakultät der Ruprecht-Karls-Universität Heidelberg.
Betreuer: Herr Prof. Dr. Manfred Cierpka (Institut für Psychosomatische Kooperationsforschung und Familientherapie, Zentrum für psychosoziale Medizin, Universitätsklinikum Heidelberg) und Herr Prof. Dr. Otwin Linderkamp (Abteilung für Neonatologie, Kinderklinik, Universitätsklinikum Heidelberg).
Titel der Dissertation: „Premature Born Infant's Reaction to the Mother's Voice in Comparison to their Reaction to Music – Effect on Heart Rate and Heart Rate Variability".

10/2002-09/2003
Vertiefungsstudium im Bereich **Eltern-Kind Interaktion als Schlüssel für Psychosomatische Erkrankungen bei Säuglingen und kleinen Kindern** am Institut für Psychosomatische Kooperationsforschung und Familientherapie, Zentrum für psychosoziale Medizin,

Universitätsklinikum Heidelberg. Für dieses Vertiefungsstudium erhielt ich ein **DAAD** (Deutscher Akademischer Austauschdienst) Stipendium. Dabei war ich an der Ruprecht-Karls-Universität Heidelberg immatrikuliert

11/1999
Facharztprüfung für den Facharzttitel Kinderärztin an der Medizinischen Fakultät der Universität in Niš

1994-1999
Weiterbildung / Fachausbildung in Kinder- und Jugendmedizin an der Medizinischen Fakultät der Universität in Niš

1993
Magisterstudium im Fachbereich Klinische Immunologie an der Medizinischen Fakultät in Niš (mit der Durchschnittsnote 10,00 bei einem Notenumfang 5-10, 5 sei keine Übergangsnote).
Magisterthese auf dem Gebiet der Reproduktivimmunologie: „Die Aktivierung des Immunsystems bei Neugeborenen aus Hoch-Risiko-Schwangerschaften in der Korrelation mit pathohistologischen Veränderungen der Plazenta“

12/1993
Staatsexamen für den Doktortitel vor der Prüfungskommission des Gesundheitsministeriums der Republik Serbien in Belgrad

1992-1993
Ärztliches Praktikum (Praktisches Jahr) an diversen Kliniken und Instituten des Universitätsklinikums Niš

1987-1992
Medizinstudium an der Universität in Niš mit der Durchschnittsnote 9,79 (Notenumfang 5-10).
Als ausgezeichnete Studentin erhielt ich während meiner Studienzeit ein **Stipendium der Republikfondation zur Weiterbildung und Entwicklung junger Künstler und Wissenschaftler**

Fort- und Weiterbildung (CME) / Seminare / Symposia / Trainings

05/2010
CME Seminar: „Nahrung und Immunsystem“, bei Herrn Prof. Dr. B. Kamenov und „Prävention nutritiver Allergien beim Neugeborenen“, bei Herrn Prof. Dr. B. Jankovic, 13. Mai 2010, Niš

11/2009
Internationales und interdisziplinäres Symposium „Aktuelle Herausforderungen der Sozialpädiatrie – kompetente Elternschaft, Früherkennung, Therapie“, sowie Pre-conference Workshop “Frühdiagnostik von Entwicklungsstörungen und ihre Konsequenzen” bei Herrn Prof. Dr. R. von Kries, Herrn Dr. F. Voigt und Herrn Dr. H. Bauer, anlässlich des Jubiläumsgeburtstags von Herrn Prof. Dr. Dr. h.c.mult. Theodor Hellbrügge, 27.-29.November 2009, München

06/2009
Psychotherapeutische Fortbildung in Baden-Württemberg: „Pioniere der Familientherapie – Teil 4 von 7“ am 09. Juni 2009 und „Pioniere der Familientherapie – Teil 5 von 7“ am 23. Juni 2009,

Psychosomatische Kooperationsforschung und Familientherapie, Universitätsklinikum Heidelberg

04/2009
59. Lindauer Psychotherapiewochen (LPTW), Fort- und Weiterbildung in Psychotherapie, wissenschaftliche Leitung von Herrn Prof. Dr. med. Manfred Cierpka, Heidelberg und Frau Prof. Dr. phil. Verena Kast, St. Gallen, Woche „Der Gewalt begegnen“, 20.-24. April 2009, Lindau am Bodensee:
1) E4 - Charles Darwins Sicht der Seele - Ein Brückenschlag zur modernen Neurobiologie, bei Herren Prof. Dr. med. Joachim Bauer & Prof. Dr. phil. Dr. rer. nat. Gerhard Roth
2) EP - Plenarvorträge zum Leitthema: Der Gewalt begegnen – Herrn Prof. Dr. med. Wolfgang Berner, Herr Prof. Dr. med. Manfred Cierpka, Frau Dr. med. Carine Minne, Frau PD Dr. med. Annette Streeck-Fischer, Herr Prof. Dr. phil. Harald Welzer
3) F14 - Psychoneuroimmunologie und Psychotherapie, Herrn Prof. Dr. med. Gerhard Schüßler
4) H47 - Funktionelle Entspannung im klinischen Alltag, Herrn Prof. Dr. med. Thomas Loew

04/2009
Lehrgang: Montessori Pädagogik und Heil-Pädagogik – bei Herrn Dipl. Päd. Joachim Dattke, Internationale Akademie für Entwicklungsrehabilitation, Kinderzentrum München, 6.-10. April 2009, Münhen

02/2009
Seminarreihe „Eltern-Säuglings-/Kleinkind-Beratung und –Psychotherapie:
Seminar B9: Schlafstörungen im Säuglings- und Kleinkindalter: Ursachen, Differentialdiagnostik und Behandlung, bei Frauen Dr. med. Margret Ziegler und Dipl. Psych. Ruth Wollwerth de Chuquisengo;
Seminar B10: Fütter-, Ess- und Gedeihstörungen im Säuglings- und Kleinkindalter: Ursachen, Differentialdiagnostik und Behandlung, bei Herrn Dr. med. Nikolaus von Hofacker, 6.-7. Februar 2009, München

01/2009
Seminarreihe „Eltern-Säuglings-/Kleinkind-Beratung und –Psychotherapie:
Seminar B5: Übertragung und Gegenübertragung in der Eltern-Säuglings-Beratung und –Psychotherapie; bei Frau Dr. med. Tamara Jacubeit,
Seminar B6: Präventive kommunikationszentrierte Eltern-Säuglings-/Kleinkind-Beratung und -Psychotherapie: ein integratives Beratungs- und Therapiekonzept bei Frau Dipl. Psych. Ruth Wollwerth de Chuquisengo, und
Seminar B8: Gesprächsführung im Rahmen der Eltern-Säuglings- und Kleinkind-Beratung, bei Frau Dipl. Psych. Ruth Wollwerth de Chuquisengo und Herrn Dipl. Psych. Dr. Michael Schieche, 9.-10- Januar 2009, München

12/2008
Seminarreihe „Eltern-Säuglings-/Kleinkind-Beratung und –Psychotherapie:
Seminar B3/7: Kommunikations- und Beziehungsdiagnostik im frühen Säuglingsalter: Zugangswege auf Interaktions- und Repräsentationsebene, bei Frau Prof. Dr. med. Mechthild Papoušek, München und Frau Dipl. Psych. Ruth Wollwerth de Chuquisengo, 5.-6. Dezember 2008, München

11/2008
International and Interdisciplinary Conference „Bindung, Angst und Aggression“, bei Herrn Dr. med. Karl-Heinz Brisch und Herrn Prof. Dr. Dr. h.c. mult. Theodor Hellbrügge, sowie Pre-

conference Workshop „Trauma, Gewalt und Medien – die Macht der äußeren Bilder und die Auswirkung auf das Gehirn“ bei Herren Lutz-Ulrich Besser und Franco Bettels, 28.-30. November 2008, München

11/2008
Seminarreihe „Eltern-Säuglings-/Kleinkind-Beratung und –Psychotherapie:
Seminar B1: Der chronisch unruhige Säugling im ersten Lebenshalbjahr: Ursachen, Differentialdiagnostik, Auswirkungen und Interventionen, bei Frauen Dipl. Psych. Ruth Wollwerth de Chuquisengo, Dr. med. Margret Ziegler, Dipl. Soz. Päd. Heike Kress und Claudia Adams, Ergotherapeutin, 7.-8. November 2008 München

11/2008
Educational Symposium of International Society for Holter and Noninvasive Electrocardiology (ISHNE), Gesellschaft für Neurokardiologie und das autonome Nervensystem Serbiens, 1. November 2008., Sava Centar, Belgrad

06/2008
Seminar „Eltern-Säuglings-/Kleinkind-Beratung und –Psychotherapie:
Seminar B16: Spiel und Spielunlust in der Frühentwicklung des Kindes: psychobiologische Grundlagen und Entwicklung, Störungen und Therapie“, bei Herrn Dr. phil. Michael Schieche, 13.-14. Juni 2008, München

05/2008
Fortbildung des Zentrums für Psychosozialen Medizin, Universitätsklinikum Heidelberg: „Beratung bei Kindern mit einer genetisch bedingten Behinderung“, bei Herrn Prof. Dr. Klaus Sarimski, 7. Mai 2008, Heidelberg

04/2008
Seminarreihe „Eltern-Säuglings-/Kleinkind-Beratung und –Psychotherapie:
Seminar B15: Frühkindliche Entwicklung, Kommunikation und Beziehung im Kontext psychischer Erkrankungen der Eltern“, bei Frau Dr. med. Christiane Deneke, 25.-26. April 2008, München

02/2008
CME Seminar "Ernährung von Neugeborenen", Universität Belgrad, Institut für Neonatologie, 7. Februar 2008, Belgrad

11/2007
International and interdisciplinary Conference „Ways towards Secure Attachment in Family and Society” / ("Wege zu sicheren Bindungen in Familie und Gesellschaft" bei Herrn Dr. med. Karl-Heinz Brisch und Herrn Prof. Dr. Dr. h.c.mult. Theodor Hellbrügge, sowie Pre-conference Workshop “The "Circle of Security" Intervention: Enhancing Secure Attachments for Preschool Children” bei Herrn Prof. Dr. Bob Marvine, The University of Virginia and The Mary D. Ainsworth Child-Parent Attachment Clinic, Charlottesville, 30. November-2. Dezember 2007, München

09/2007
Fortbildung des Zentrums für Psychosozialen Medizin, Universitätsklinikum Heidelberg „Development of an Object Relations Treatment for Borderline Pathology“ bei Herrn Prof. Dr. John F. Clarkin, Cornell University New York City

06/2007
Seminarreihe „Eltern-Säuglings-/Kleinkind-Beratung und –Psychotherapie: Hospitationswoche C “Eltern-Säuglings-/Kleinkind-Beratung und –Psychotherapie“ bei Frau Prof. Dr. med. Mechthild Papoušek, 25.-29. Juni 2007, München

01/2007
Fortbildung des Zentrums für Psychosozialen Medizin, Universitätsklinikum Heidelberg: „Rolle und Funktion des Spiegelneuronensystems“ bei Herrn Dr. Giovanni Buccino, Parma

01/2007
Fortbildung des Zentrums für Psychosozialen Medizin, Universitätsklinikum Heidelberg: „Dysphorische Bewegungsunruhe und Spielunlust in der frühen Kindheit – Vorläufer vom ADHS?“ bei Frau Prof. Dr. med. Mechthild Papoušek, München

12/2006
International and interdisciplinary Conference „The Infant – Attachment, Neurobiology and Genes. Essentials for Prevention, Counselling and Therapy“ bei Herrn Dr. med. Karl-Heinz Brisch und Herrn Prof. Dr. Dr. h.c.mult. Theodor Hellbrügge, sowie Pre-conference Workshop “Neurodevelopment and care of the preterm infant: From protocol to relationship” bei Frau Prof. Dr. Heidelise Als, NIDCAP Entwicklerin, Harvard Medical School, Boston, 1.-3. Dezember 2006, München

10/2006
Fortbildung des Zentrums für Psychosozialen Medizin, Universitätsklinikum Heidelberg: „Der Trauerprozess – therapeutische Gesichtspunkte“ bei Frau Prof. Dr. phil. Verena Kast, St. Gallen

03/2006
Symposium “Entwicklungsfördernde und Familienzentrierte Betreuung Frühgeborener” unter der wissenschaftlichen Leitung von Herrn Prof. Dr. Otwin Linderkamp, Abteilung Neonatologie, Universitäts-Kinderklinik, Universitätsklinikum Heidelberg und Frau Prof. Dr. Heidelise Als, NIDCAP® Entwicklerin, Harvard Medical School, Boston, 18.-19. März 2006, Heidelberg

03/2006
Vorbereitende Sitzung zur Gründung einer internationalen Gesellschaft zur Weiterbildung in prä- und perinataler Psychologie und Medizin, 4.-5. März, 2006, Rimini

12/2005
International and interdisciplinary Conference „The Beginnings of Parent-Infant Bonding and Attachment – Pregnancy, Birth and Role of Psychotherapy“ bei Herrn Dr. med. Karl-Heinz Brisch und Herrn Prof. Dr. Dr. h.c.mult. Theodor Hellbrügge, sowie Pre-conference Workshop “When survivors become mothers: Diagnostics and psychotherapy of pregnant women after sexual abuse by EMDR” bei Frau Phyllis Klaus, Berkeley, 2.-3. Dezember 2005, München

10/2005
8. Interdisziplinäres Symposium “Individuelle Betreuung von Frühgeborenen und ihren Eltern” unter der wissenschaftlichen Leitung von Herrn Dr. med. Friedrich Porz, Herrn Prof. Dr. Otwin Linderkamp und Frau Dr. med. Skadi Springer, 15.-16. Oktober 2005, Heidelberg

09/2005

„Ethische, rechtliche und soziale Aspekte des Neuro-Enhancements“, Klausurwoche bei Frau Prof. Dr. Bettina Schöne-Seifert, Herrn Uwe Opolka und Frau Davinia Talbot, 20.-27. September, Hanse-Wissenschaftskolleg, Delmenhorst

08/2005
2nd Hanse Workshop of HEARing Research: “Sensory worlds: a comparative view on sensory perception” bei Herrn Prof. Dr. Georg Klump, 11.–14. August 2005, Hanse-Wissenschaftskolleg, Delmenhorst

06/2005
Konferenz „Willensfreiheit und rechtliche Ordnung“ bei Herrn Prof. Dr. Michael Pauen, Herrn Prof. Dr. Ernst Joachim Lampe und Herrn Prof. Dr. Dr. Gerhard Roth, 9.-11. Juni 2005, Hanse-Wissenschaftskolleg, Delmenhorst

06/2005
XVI Internationaler Kongress der Internationalen Studiengemeinschaft für Pränatale und Perinatale Psychologie und Medizin (ISPPM) „Anthropologie und Psychologie von Schwangerschaft und Geburt“, 2.-5. Juni 2005, Heidelberg

05/2005
Die internationale and interdisziplinäre Konferenz „Fortschritte in der Stillberatung“, bei Frau Dr. med. Susanne Jonat und Herrn Prof. Dr. Dr. h.c. mult. Theodor Hellbrügge, 6.-7. Mai 2005, München

03/2005
„Gewalt im Spiel - Psychoanalytische Betrachtungen gewaltsamer Beziehungsformen“, Institut für Psychoanalyse und Psychotherapie Heidelberg-Mannheim, 10. März 2005

12/2004
Gewaltpräventions-Curriculum FAUSTLOS für den Kindergarten bei Herrn M.A. Götz Egloff, FAUSTLOS – Heidelberger Präventionszentrum, 2. Dezember 2004, Heidelberg

10/2004
The International and Interdisciplinary Conference „Children without Attachment – Deprivation, Adoption and Psychotherapy“, bei Herrn Dr. med. Karl-Heinz Brisch und Herrn Prof. Dr. Dr. h.c. mult. Theodor Hellbrügge, 29.-30. Oktober 2004, München

10/2004
1. Neonatologiesches Symposium bei Herrn Prof. Dr. Otwin Linderkamp, Abteilung Neonatologie, Universitäts-Kinderklinik, Universitätsklinikum Heidelberg, 2. Oktober 2004, Heidelberg

09/2004
Seminar „Desorganisierte Bindung und Video-Mikroanalyse-Therapie“ bei Herrn Dr. phil. George Downing, Salpêtrière Hospital, Paris & Universität Klagenfurt, Abteilung für Klinische Psychologie, 23.-25. September 2004, Heidelberg

03/2004
Training in „Emotional Availability Scales“ (inkl. abgeschlossener Reliabilitätstest) bei Frau Prof. Dr. Zeynep Biringen, Colorado State University, Department of Human Development & Family Studies, am 23.-27. März 2004, Heidelberg

11/2003
„Herbstversammlung der Schweizerischen Gesellschaft für Neonatologie“ bei Herrn Prof. Dr. Hubert Fahnenstich, Universitäts-Kinderspital beider Basel am 18. Novembar 2003, Basel

07/2003
Seminarreihe „Eltern-Säuglings-/Kleinkind-Beratung und –Psychotherapie:
Seminar K: Kompaktkurs für Kinder- und Jugendärzte – Exzessives Schreien, Schlaf- und Fütterstörungen – ein Leidfaden für die kinderärztliche Praxis“, bei Frau Dr. med. Margret Ziegler und Frau Prof. Dr. med. Mechthild Papoušek, 19. Juli 2003, München

06-07/2003
Teilnahme an der 53. Tagung der Nobelpreisträger - 18. Treffen der Medizinier, 30. Juni - 04. Juli 2003, Lindau am Bodensee

06/2003
Seminarreihe „Eltern-Säuglings-/Kleinkind-Beratung und –Psychotherapie:
Seminar B:14 Entwicklungsdynamik und Störungen von Selbstvertrauen und Autonomie“, bei Frau Prof. Dr. med. Mechthild Papoušek, Herrn Dr. Michael Schieche und Frau Dipl.-Psych. Claudia Rupprecht, 20.-22. Juni 2003, München

06/2003
Training „Münchener Kommunikationsdiagnostik für klinische Anwendung“ bei Frau Prof. Dr. med. Mechthild Papoušek, Institut für Soziale Pädiatrie und Jugendmedizin der Ludwig-Maximilians-Universität München, Abteilung für Entwicklungspsychobiologie, 10.-12. Juni 2003, Heidelberg

05/2003
Symposium der Universitäts- Kinder- und Frauenklinik Mannheim „Förderung der Mutter-Kind Beziehung und der kindlichen Entwicklung“, 10. Mai 2003, Mannheim

05/2003
Symposium der Abteilung Kinder- und Jugendpsychiatrie der Psychiatrischen Universitätsklinik Heidelberg „Krise-Krankheit-Entwicklung - 10 Jahre Entwicklungspsychopathologie in Heidelberg“ bei Herrn Prof. Dr. med. Franz Resch, 9. Mai 2003, Heidelberg

04/2003
53. Lindauer Psychotherapiewochen, Fort- und Weiterbildung in Psychotherapie, wissenschaftliche Leitung von Herrn Prof. Dr. med. Manfred Cierpka, Heidelberg und Frau Prof. Dr. phil. Verena Kast, St. Gallen, Woche „Kindheit hat Folgen!“, 12.-17. April 2003, Lindau am Bodensee:

1) Die Vorlesungen „Entwicklungsbedingungen und fördernde Umwelt“ bei Frau Prof. Dr. Inge Seiffge-Krenke;
2) Die Plenumsvorträge zum Leitthema „Kindheit hat Folgen!“:

„Die Konsequenzen des Gehorsams für die Entwicklung von Identität und Kreativität“ - Herr Prof. Dr. Arno Gruen;
„Langzeitfolgen früher Stresserfahrungen für die Gesundheit im Erwachsenenalter“ - Herr Prof. Dr. med. Ulrich Tiber Egle;
„Kinder- und Familienschicksale“ - Herr Prof. Dr. Dr. Dr. Wassilios E. Fthenakis;
„The Relation of Adverse Childhood Experiences to Adult Health“- Herr Vinsent J. Felitti,MD;

„Beziehungserfahrungen in der Kindheit und ihre Auswirkung auf spätere Vorstellungen über Beziehungen und Partnerschaft“ - Frau Dr. phil., Dipl.-Psych. Karin Grossmann und Herr Prof. Dr. phil., Dipl.-Psych. Klaus E. Grossmann;
„Es gibt immer eine zweite Chance“ - Herr Prof. Dr. med. Manfred Cierpka; und
3) Seminar: „Einführung in die Traumatherapie“ bei Herrn Prof. Dr. med. Friedhelm Lamprecht

03/2003
Seminarreihe „Eltern-Säuglings-/Kleinkind-Beratung und –Psychotherapie:
Seminar B13: Videogestützte Interaktionsleitung: Intensivtraining“, bei Frau Prof. Dr. med. Mechthild Papoušek, Frau Dipl.-Psych. Ruth Wollwerth de Chuquisengo und Herrn Dr. Michael Schieche, 28.-30. März 2003, München

03/2003
Seminarreihe „Eltern-Säuglings-/Kleinkind-Beratung und –Psychotherapie:
Seminar B11: Entwicklungsdynamik und Störungen von Bindung und Exploration“, bei Frau Prof. Dr. med. Mechthild Papoušek, Herrn Dr. Michael Schieche und Frau Dipl. Psych. Claudia Rupprecht, 7.-9. März 2003, München

01-02/2003
Seminar „Video-Mikroanalyse-Therapie: Arbeit mit Affekten in der VMT“ bei Herrn Dr. phil. George Downing, 30. Januar - 01. Februar 2003, Heidelberg

11/2002
International and Interdisciplinary Conference „Time Structures – Chronomes – in Child Development“, bei Herrn Prof. Dr. Dietrich Reinhardt und Herrn Prof. Dr. Dr. h.c.mult. Theodor Hellbrügge, 29.-30. November 2002, München

11/2002
Lehrgang “Video- und computergestützte Analyse und Auswertung von frühen Mutter-Kind-Interaktionen“ - für Fortgeschrittene, bei Herrn Dipl.-Psych. Robert Weiss, 14.-28. November 2002, München

10/2002
Internationales und interdisziplinäres Symposium „Hören und Sprechen lernen“ – Neurophysiologische Aspekte und Entwicklung früher Dialoge bei hörgeschädigten Säuglingen und Kleinkindern, Internationales und interdisziplinäres Symposium zur Würdigung von Professor Armin Löwe, bei Frau Prof. Dr. Ursula Horsch und Herrn Prof. Dr. Dr. h.c.mult. Theodor Hellbrügge, 25.-26. Oktober 2002, Heidelberg

10/2002
Seminarreihe „Bekannte Familientherapeutinnen und –therapeuten in Aktion“, Abteilung für Psychosomatische Kooperationsforschung und Familientherapie der Psychosomatische Klinik Heidelberg - Vorlesungen bei Herrn Dr. med. Gunthard Weber, Wieslocher Institut für Systemische Lösungen und Helm-Stierlin-Institut, Heidelberg, und Frau Dipl.-Soz.päd. Heidi Salm, Familien-, Gestalt- und Körpertherapeutin in eigener Praxis, Heidelberg

01/2002
Internationales und interdisziplinäres Symposium: „Frühdiagnostik von Hörstörungen und frühe Hör-Sprach-Förderung hörbehinderter Kinder“, bei Herrn Prof. Dr. Dr. h.c.mult. Theodor Hellbrügge und Herrn Prof. Dr. habil. Klaus-Dietrich Große, 25.-26. Januar, Berlin

01/2002
Wissenschaftliches Symposium: „Regulationsstörungen der frühen Kindheit. Frühen Risiken - frühe Hilfen. Bilanz aus 10 Jahren Münchener Sprechstunde für Schreibabys“, bei Herrn Prof. Dr. Dr. h.c. Hubertus von Voss und Frau Prof. Dr. Mechthild Papoušek, 18.-19. Januar, München

10-11/2001
Lehrgang: „Video- und Computergestützte Analyse und Auswertung von frühen Mutter-Kind Interaktionen“ für Anfänger, bei Frau Prof. Dr. med. Mechthild Papoušek und Herrn Dipl.-Psych. Robert Weiss, München

10/2001
Seminar: „Musiktherapie in der Behandlung von Kindern und Jugendlichen mit Entwicklungsstörungen und Behinderungen“, bei Frau Dr. Melanie Voigt, München

10/2001
Seminarreihe „Eltern- Säuglings- und Kleinkindberatung und –Psychotherapie: Grundlagenseminar A: Grundlagen und Störungen der vorsprachlichen Kommunikation“, bei Frau Prof. Dr. med. Mechthild Papoušek, München

10/2001
Seminar: „Münchener funktionelle Entwicklungsdiagnostik (MFED) für das 1.-3. Lebensjahr“, bei Herrn Dr. med. Stefan Rank, Juni, Belgrad und bei Frau Dr. Barbara Ernst, Oktober, München

03/1996
UNICEF Seminar & Certificate: „Baby Friendly Educator“, bei der UNICEF Kanzlei in Belgrad und Bundesinstitut für Gesundheitsförderung, 14.-16. März 1996, Niš

05-06/1995
1. Jugoslawischer Perinatalpathologiescher Kurs: „Klinische Bedeutung der Perinatalpathologie“, bei Herrn Dr. Djerdj-George Kokai, Department of Pathology, University of Wales College of Medicine, Cardiff, 31. Mai – 02. Juni 1995, Belgrad

Sprachkenntnisse

08/2002-10/2002
Intensivkurs: Deutsch als Fremdsprache: Oberstufe (C1) - Sprachkurs mit insgesamt 200 Unterrichtsstunden am Deutsch-Institut „Deutsch in Deutschland“ in Frankfurt am Main

1999-2002
Besuch und erfolgreicher Abschluss von sieben Fremdsprachkursen in Deutsch am Fremdspracheninstitut „Pavle Stojkovic“ und an der Fremdsprachenschule „Fischer“ in Niš unter der Leitung von DAAD-Lektorin Frau Angela Fischer-Markovic

1996
Besuch und erfolgreicher Abschluss von zwei Sprachkursen in Französisch beim Fremdspracheninstitut „Pavle Stojkovic“ in Niš

06/1993

Internationale Prüfung für das „Certificate in Advanced English (C) – University of Cambridge", The British Council in Belgrad

Computerkenntnisse

Computerkenntnisse und Erfahrungen in DOS und Windows Programmen:
Sehr gute PC Anwenderkenntnisse in Microsoft Office (Word, Access, Excel, Power Point, Front Page, Outlook, SPSS), den Standard Internet Browsern Internet Explorer, Netscape, Opera, etc. sowie CorelDraw, Adobe Acrobat, WinZip, GetRight.
Sehr gute Anwenderkenntnisse in Text-Bearbeitungs-Programmen (Text-Editors) LaTex und Ams Tex

Berufserfahrung und Praxis:

ab 10/2007-
Kinderfachärztin an der Universitäts-Kinderklinik Niš, Abteilung für **Neonatologie**, Universitätsklinikum Niš

05/2004-04/2005 sowie ab 07/2006-10/2006
Im Rahmen der Promotion tätig als **wissenschaftliche Mitarbeiterin** am Institut für Psychosomatische Kooperationsforschung und Familientherapie, Zentrum für Psychosoziale Medizin, Universitätsklinikum Heidelberg

09/2003-12/2003
Assistenzärztin zur Weiterbildung mit Schwerpunkt Neonatologie an dem Universitäts-Kinderspital beider Basel (UKBB)

10/2002-09/2003
Gastärztin in der Eltern-Säuglings-Sprechstunde - Diagnostik, Beratung und Therapie von der Psychosomatischen Erkrankungen bei Säuglingen und kleinen Kindern an der Abteilung für Psychosomatische Kooperationsforschung und Familientherapie, Psychosomatische Klinik, Universitätsklinikum Heidelberg

07/2000-09/2002
Kinderfachärztin an der Universitäts-Kinderklinik, Abteilung für **Kinder-Kardiologie**, Universitätsklinikum Niš

04/1994-07/2000
Ärztin in Weiterbildung / Fachausbildung für Kinder- und Jugendmedizin sowie Kinderfachärztin an der Abteilung für **Neonatologie** der Klinik für Frauenheilkunde und Entbindung am Universitätsklinikum Niš

07/1991
Klinische Praxis (1 Monat) an der Abteilung für Chirurgie im San Raffaele Krankenhaus, Universität Mailand, unter der Leitung von Herrn Prof. Dr. Luciano Olmi

07/1990

Klinische Praxis (1 Monat) an der Klinik für Kardiologie im Universitätsklinikum Niš, unter der Leitung von Herrn Prof. Dr. Vitomir Ciric

10/1988-04/1994
Forschungsaktivitäten im Rahmen nationaler und internationaler wissenschaftlicher Projekte am Labor für Immunologie und Genetik, Medizinische Fakultät in Niš, unter der Leitung von Herrn Prof. Dr. Borislav Kamenov.

09/1993 – 04/1994
Als **Stipendiatin des Forschungsministeriums der Republik Serbien** tätig in einem wissenschaftlichen Projekt im Bereich der „Experimentellen Forschung des chematopoesischen Systems“ (unter der Leitung von Herrn Prof. Dr. med. Zoran Rolovic, Belgrad) sowie im Projekt „Chematopoesische Störungen der Stammzelle“ (unter der Leitung von Herrn Prof. Dr. med. Borislav Kamenov, Niš)

1989-1992
Als Studentin beteiligte ich mich intensiv an der Arbeit im Zentrum für wissenschaftliche Arbeit der Studenten an der Universität in Niš (CNIRS), und leitete das Zentrum für zwei Jahre (1990/91 und 1991/92).

10/1989-10/1992
Tutorin am Institut für Histologie und Institut für pathologische Histologie an der Medizinischen Fakultät, Universität in Niš

Organisatorische Erfahrungen

07/2004
Organisation der Promotionsfeier im Namen des Rektorats der Universität Heidelberg für Promovierte an der Medizinischen Fakultät (Auftrag von Herrn Prof. Dr. med. Jochen Tröger)

1994-2002
Als Ärztin in Fachausbildung und als Fachärztin beteiligte ich mich an der Organisation von Tagungen der Gynäkologen sowie Tagungen der Kinderärzte Jugoslawiens

1992
Als Leiterin des Zentrums für wissenschaftliche Studien der Studenten an der Universität in Niš (CNIRS) organisierte ich den XXXIV Kongress der Medizin- und Stomatologiestudenten Jugoslawiens, Niška Banja 1992

Mitgliedschaften

Ärztliche Gesellschaft Serbiens (SLD) - Pädiatriescher Verein

Gesellschaft für Neurokardiologie und das autonome Nervensystem Serbiens

Immunological Society of Serbia

International Union of Immunological Societies and World Allergy Organization

Gesellschaft für Seelische Gesundheit in der Frühen Kindheit e.V. German-speaking Association for Infant Mental Health (GAIMH)

Internationale Gesellschaft für pränatale und perinatale Psychologie und Medizin (ISPPM)

Vorträge auf Einladung:

06/2010
„Wohlbefinden der Mutter und HRV des Kindes" im Rahmen des CME Seminars: „Neue Methoden zur Evaluation der Regulation des Kardiovaskulären Systems mittels des autonomen Nervensystems", Serbische Ärztliche Gesellschaft – Sektion Autonomes Nervensystem, Medizinische Fakultät Belgrad, 16.-17. Juni 2010, Belgrad

04/2010
„Preterm Infant's reaction to Mother's Voice in Comparison with Reaction to Music" - Posterpräsentation zur Jubiläumstagung des Instituts für Psychosomatische Kooperationsforschung und Familientherapie „„… Eltern sein dagegen sehr!", 15.-17- April 2010, Heidelberg

03/2010
"Die Kommunikation mit Kindern – Präverbale Kommunikation Eltern-Kind" u okviru predmeta "Einführung in die klinische Praxis" für Studenten der Vorklinik, Medizinische Fakultät Niš 10. und 11. März 2010

05/2009
"Parenting in early childhood as epigenetic factor of resistence on stress and inflammation" im Rahmen des CME Seminars: "Inflammation in different pathological conditions in childhood – new insights", Medizinische Fakultät Niš, 29. Mai 2009

04/2009
„Bindung als Voraussetzung für eine erfolgreiche Frühbehandlung" auf dem internationalen Symposium "Interdisziplinäre diagnostische und therapeutische Interventionen bei Entwicklungsstörungen in der frühesten Kindheit ", 17. April 2009, Universitätskinderklinik Plovdiv, Bulgarien

03/2009
"Eigenschaften der Kommunikation mit Kindern – Präverbale Kommunikation zwischen Eltern und Kind" im Rahmen des Faches "Einführung in die klinische Praxis" für Studenten der Vorklinik Medizin, Medizinische Fakultät der Universität in Niš, 18. und 19. März 2009, Niš

03/2009
„Interrelations between wellbeing of the mother and heart rate variability of preterm infant" beim Treffen der Sektion für Neurokardiologie und autonomes Nervensystem, Serbische Ärztliche Gesellschaft, 11. März 2009, Belgrad

12/2007

"Exzessives Schreien als Regulationsstörung im frühen Säuglingsalter – ‚Dreimonatskoliken' aus der Sicht der Psychosomatik", beim Treffen der Sektion für Pädiatrie Pozarevac, Serbische Ärztliche Gesellschaft, 13. Decembar 2007, Kostolac

11/2007
"Exzessives Schreien als Regulationsstörung im frühen Säuglingsalter – ‚Dreimonatskoliken' aus der Sicht der Psychosomatik", beim Treffen der Sektion für Pädiatrie Niš, Serbische Ärztliche Gesellschaft, 13. Novembar 2007, Leskovac

10/2007
"Heidelberger Konzept der Betreuung Frühgeborener und kranker Neugeborener: Minimierung der Intensivmedizin auf das unbedingt Notwendige und Maximierung der Zuwendung zum Kind und seiner Familie", 24. Oktober 2007, Universitätskinderklinik Niš

Veröffentlichungen und Konferenzpräsentationen:

Seit 1989-

40. Djordjevic D., Brüssau J., Linderkamp O, Cierpka M.: Effect of Mother's Voice and Lullaby Music on Heart Rate Variability in Preterm Infants. (in Vorb.)

39. Djordjevic D.: Entwicklungsdynamik der Kind-Eltern Bindung und Störungen der Bindung und Exploration (in Serb.). Tagung der serbischen Kinderärzte, Niš 2008

38. Djordjevic D. und Pešić Z.: Eitrige Entzündung der Ohrspeicheldrüse im neugeborenen Alter - Fall Bericht (in Serb.). Tagung der serbischen Kinderärzte, Niš 2008

37. Djordjevic D., Linderkamp O., Brüssau J., Cierpka M. Zusammenhänge zwischen dem Wohlbefinden der Mutter und der Herzfrequenzvariabilität von Frühgeborenen. Praxis der Kinderpsychologie und Kinderpsychiatrie, 2007; 56: 852-869

36. Djordjevic D., Weiss R., Papoušek M. Eltern-Kind Interaktionsdiagnostik nach Papoušek. III Kongress der Kinderärzten Jugoslawiens/Serbiens und Montenegros (in Serb.), Herzeg Novi 2002

35. Djordjevic D., Kamenov B., Katic V., Milosavljevic M.: Immune System Activation in Newborns from High-Risk Pregnancies). 11th International Congress of Immunology, Stockholm 2001

34. Pejcic Lj., Djordjevic D. Herzinsuffizienz als therapeutisches Problem (in Serb.). Tagung der jugoslawischen Kinderärzte, Niš 2001

33. Stojanovic N., Sljivic S., Stojanovic M., Milosavljevic M., Djordjevic D., Jovanovic G., Jovcic S. Hernia diaphragmalis und Regulationsstörungen der Immunantwort - Fall Bericht (in Serb.). Tagung der jugoslawischen Kinderärzte, Niš 2001

32. Stojanovic M., Sljivic S., Stojanovic N., Milosavljevic M., Djordjevic D., Ilic R., Jovcic S. Gastroschisis und Regulationsstörungen der Immunantwort - Fall Bericht (in Serb.). Tagung der jugoslawischen Kinderärzte, Niš 2001

31. Djordjevic D., Sljivic S., Pejcic Lj., Kamenov B., Stojanovic M., Stojanovic N. Die pränatale Aktivierung des Immunsystems bei Neugeboren mit angeborenen Herzfehlern (in Serb.). Tagung der jugoslawischen Kinderärzte, Niš 2001

30. Sljivic S., Djordjevic D., Stojanovic M., Stojanovic N., Milosavljevic M., Tasic G., Mrkaic Lj., Brankovic Lj., Mihailovic D., Milenovic D., Jovcic S. Angeborene Anomalien und die Immunantwort (in Serb.). Tagung der jugoslawischen Kinderärzte, Niš 2001

29. Djordjevic D., Sljivic S., Pejcic Lj., Kamenov B., Jovanovic G., Kutlesic R. Mihailovic D. Inzidenzen und Strukturen der angeborenen Herzfehlern unter dem verstärkten Einfluss von teratogenen Faktoren (in Serb.). III Kongress der Kardiologen Serbiens, Belgrad 2000

28. Pejcic Lj., Djordjevic D. Dilatationale Cardiomiopathie im frühen Kindesalter (in Serb.). III Kongress der Kardiologen Serbiens, Belgrad 2000

27. Djordjevic D., Sljivic S., Kamenov B., Miljkovic B., Jovanovic G., Milosavljevic M.: Immune Response Disorders in Neonates with Intrauterine Growth Retardation). 1st World Congress of Perinatal Medicine in Developing Countries, Tuzla, Bosnia and Herzegovina, 2000

26. Sljivic S., Milosavljevic M., Djordjevic D., Stojanovic M., Stojanovic N., Mihailovic D., Tasic G., Mrkaic Lj., Milenovic D.: Ectopio Cordis and Immune Response - case report). 1st World Congress of Perinatal Medicine in Developing Countries, Tuzla, Bosnia and Herzegovina, 2000

25. Sljivic S., Milosavljevic M., Tasic G., Djordjevic D., Stojanovic M., Stojanovic N., Mrkaic Lj., Brankovic Lj., Mihailovic D., Nikolic S., Milosavljevic B.: Altered Immune Response in Children with Congenital Anomalies. 2nd Macedonian Congress of Immunology - Macedonian medical review, 2000; 54 (suppl 43): 368-369

24. Djordjevic D., Sljivic S., Kamenov B., Pejcic Lj., Milosavljevic M., Tasic G. Immune System Activation in Neonate with Hypoplastic Left Heart Syndrome - case report. 2nd Macedonian Congress of Immunology - Macedonian medical review, 2000; 54 (suppl 43): 367-368

23. Sljivic S., Milosavljevic M., Djordjevic D., Tasic G., Stojanovic N., Stojanovic M., Mrkaic Lj., Brankovic Lj., Milenovic D., Nikolic S.: In welchem Bezug steht die Art der Geburt mit frühen neonatalen Problemen (in Serb.). XVII Tagung der Gynäkologen, Niš 2000

22. Miladinovic P., Pop-Trajkovic Z., Radovic M., Djordjevic D., Stankovic Z. Mögliche Verletzungen der Entbindenden und Neugeborener bei operativer Entbindung – Schlussfolge (in Serb.). XVII Tagung der Gynäkologen, Niš 2000

21. Djordjevic D., Nikolic J., Stefanovic V. Ethanol interactions with other cytochrome P450-substrates including drugs, xenobiotics, and carcinogens. Pathologie Biologie, 1998;46(10):760-770

20. Dimitrijevic H., Kamenov B., Fahredin J., Milicevic R., Eferica I., Djordjevic D. Schwäche der Immunoregulation bei Patienten mit Bronchialasthma (in Serb.). Tagung der Jugoslawischen Kinderärzte, Niš 1997

19. Kamenov B., Dimitrijevic H., Mihajlovic G., Brankovic Lj., Sljivic S., Eferica I., Djordjevic D., Fahredin J., Tasic G. Angeborene Anomalien bei Kindern deren Mütter ein chronisch

unreguliertes Immunsystem aufweisen (in Serb.). Tagung der Jugoslawischen Kinderärzte, Niš 1997

18. Miladinovic P., Petric A., Djordjevic D., Jonovic M. Das frühzeitige Platzen der Eihäute bei Frühgeborener und Neugeborener (in Serb.). Treffen der Perinatologen Serbiens und Montenegros, Becici 1995

17. Kamenov B., Dimitrijevic H., Georges J., Milenovic D., Najman S., Djordjevic D. Störungen der Immunoregulation bei Kindererkrankungen (in Serb.). Tagung der Jugoslawischen Kinderärzte, Niš 1995

16. Djordjevic D., Najman S., Kamenov B., Stankovic T. Die Entwicklung der humanen Knochenmarkkultur modifiziert durch Dexamethazon (in Serb.). Serbisches Archiv, 1994; 122(Anh.):42-45

15. Mrkaic Lj., Obradovic V., Miljkovic B., Bjelakovic B., Djordjevic D. Die Häufigkeit der kongenitalen Anomalien bei Neugeborenen an der Frauenklinik in Niš von 1992-1993 (in Serb.). XV Tagung der Gynäkologen, Niš 1994

14. Bjelakovic B., Miladinovic P., Obradovic V., Mrkaic Lj., Miljkovic B., Bjelakovic B. B., Djordjevic D. Morbidität bei frühgeborenen Kindern an der Frauenklinik in Niš im Zeitraum 1992-1993 (in Serb.). XV Tagung der Gynäkologen, Niš 1994

13. Djordjevic D., Najman S., Kamenov B., Stankovic T., Bakic M. Die Modifikation der Entwicklung der humanen Knochenmarkkultur unter dem Einfluss von Dexamethazon (in Serb.). Jährliches Treffen des Vereins der Allergologen und klinischen Immunologen Jugoslawiens, Niš 1993

12. Najman S., Kamenov B., Stankovic T., Djordjevic D., Brankovic Lj. Die Aktivierung des Fagozythen Systems bei Mäusen unter 2-butoxietanol (in Serb.). Wissenschaftliches Treffen der Immunologen Jugoslawiens, Belgrad 1993

11. Kamenov B., Najman S., Dimitrijevic H., Vojinovic J., Brankovic Lj., Djordjevic D., Stankovic T., Milenovic D., Bakic M. Kortikosteroide als Modulatoren der Zellenproliferation, Zellendifferenzierung und des Zelleninhaltes der Knochenmarkstroma in langhaltenden Kulturen (in Serb.). IX Symposum für Kinderchematologie, Immunologie und Onkologie - Bulletin für Chematologie und Transfuziologie, 1993; 21(1):44

10. Stankovic T., Djordjevic D. Methylprednizolon erhöht die Befreiung der Zellen des Myelostamms aus dem Knochenmark und die fagozythen Eigenschaften den Polymorphonuklearen (PMN) des Blutes bei Mäusen unter dem Einfluss von 2-Butoxyäthanol (in Serb.). XXXV Kongress der Medizin- und Stomatologiestudenten Jugoslawiens, Zlatibor 1993

9. Djordjevic D., Stankovic T. Dexamethazon unterstützt die Reduktionsmöglichkeiten von Nitroblue-Tetrazolium in der langehaltenden Kultur des humanen Knochenmarks (in Serb.). XXXV Kongress der Medizin- und Stomatologiestudenten Jugoslawiens, Zlatibor 1993

8. Zlatic A., Djordjevic D. Der Inhalt des reduzierten Glutatyon in der regenerierenden Leber von Ratten (in Serb.). XXXIV Kongress der Medizin- und Stomatologiestudenten Jugoslawiens, Niška Banja 1992

7. Djordjevic D., Stankovic T. Der Einfluss von Dexamethazon auf die Entwicklung von Fettzellen in der langehaltenden Kultur des Knochenmarks (in Serb.). XXXIV Kongress der Medizin- und Stomatologiestudenten Jugoslawiens, Niška Banja 1992

6. Antovic J., Djordjevic D. Äther-Glykol Effekt auf den Koagulationstatus der Wisterratten (in Serb.). XXXIII Kongress der Medizin- und Stomatologiestudenten Jugoslawiens, Sarajevo 1991

5. Djordjevic D., Antovic J. Äther-Glykol Effekt auf die Zellenproduktion und Zellenfunktion des Myelostamms (in Serb.). XXXIII Kongress der Medizin- und Stomatologiestudenten Jugoslawiens, Sarajevo 1991

4. Djordjevic D., Antovic J. Äther-Glykol Effekt auf den chematologischen Status bei BALB/c Mäusen (in Serb.), Oktobertreffen, Niš 1990

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