High Technology Environment and intermittent KC procedure Results on Psychological Variables

Maria A Tallandini & Lucia Genesoni

University of Triest. Italy, and University College London UK

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There is a direct link between:
infant's neuropsychological development

and

the infant's very early experiences within primary environment.

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The development of the brain systems involved in cognitive processes depend upon the dynamic interaction between genetic factors and environmental influences (Grossmann & Johnson, 2007; Friederici, 2006; Grossmann, Churchill, McKinney, Kodish, Otte, & Greenough, 2003).

The environmental factors and early experiences play a crucial role in early developmental years in

- **coordinating the timing and patterns of gene expression,** which determines initial brain architecture **during the prenatal and the early postnatal periods** (Fox, Levitt & Nelson, 2010; Hertzman, 2000; Meaney, 2010; Shonkoff, 2010; Shonkoff, Boyce, & McEwen, 2009).

- **the development of basic cognitive processes** (Grossmann et al., 2003; Knudsen, 2004; Pascual Leone & Johnson, 2005).

⬇

Preterm infants are exposed to a very different initial post-natal environment, at a much earlier stage of growth compared to full term infants. This can place them at higher risk of maladaptive development.

- **Initial experiences are biologically embedded in the infant's early development, having a long-term impact on the mastery of cognitive, language and social skills (Shonkoff, 2010).**

- **These interactions, in some cases, begin as early as the prenatal period (Davis & Sandman, 2010; D'Onofrio et al., 2010).**

Preterm infant population

the infant at birth presents a different biological stage of development compared to the full term infant.

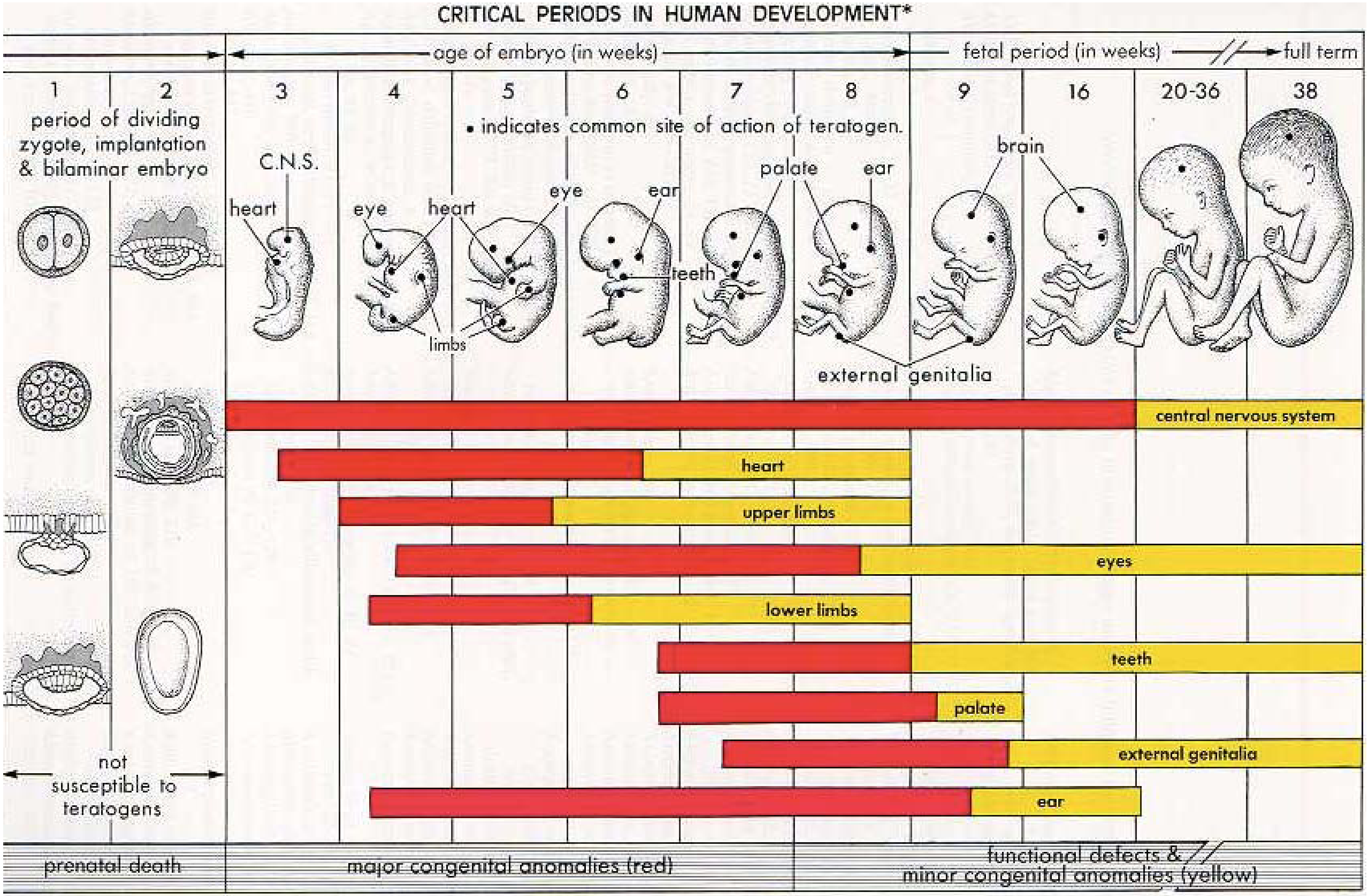
perinatal environmental stimulation plays an essential role for the child's growth and development.

Environmental influences include :

the type and the modality of stimulations that the infant receives

the inter-relational experiences of the infant with his/her social realm.

Developmental processes are understood in the context of evolving biological systems as they interact with the social realm (Grossmann & Johnson, 2007; Sameroff, 2010; Schore, 2010; Shonkoff, 2010).


CRITICAL PERIODS IN HUMAN DEVELOPMENT*
age of embryo (in weeks)
fetal period (in weeks)
full term
1
2
3
4
5
6
7
8
9
16
20-36
38
period of dividing zygote, implantation & bilaminar embryo
• indicates common site of action of teratogen.
C.N.S.
heart
eye
heart
eye
ear
teeth
palate
ear
brain
limbs
external genitalia
central nervous system
heart
upper limbs
eyes
lower limbs
teeth
palate
external genitalia
ear
not susceptible to teratogens
prenatal death
major congenital anomalies (red)
functional defects & minor congenital anomalies (yellow)

The structure of the brain architecture is established in the prenatal period

From last trimester of pregnancy, the brain is in a critical period of accelerated growth, because of myelination, reorganisation of synapses and the programmed death of cells

It requires

At a biological level
a sufficient amount of nutrients (Levitsky & Strupp, 1995). ;

At a psychological level
regulated interpersonal experiences (for maturation at a structural and functional level (Fox et al., 2010)) which are the basis for receiving, interpreting, and acting on information originating in the external world (Hammock & Levitt, 2006).

The refinement in the neural circuits that mediate sensory, emotional and social behaviours are driven by the infant's early experiences within the primal environment, such as the quality of interaction with the caregivers (Feldman & Knudsen, 1998).

Early experiences nurturing, stable, and predictable, promote healthy brain development

Early experiences fraught with threat, uncertainty, neglect or abuse, can disrupt developing brain circuitry,

Experience-dependent mechanisms of brain network formation and maturation may be responsible for such changes when children are placed in a positive or adversely stimulating environment (Fox et al., 2010).

Enrichment may lead to a restoration of typical development.

Negative experiences produce a greater level of vulnerability in the child's physical and mental health.

Gestation : 24 weeks

- Motor developmental delays are well documented in preterm children
- Language delay is also a well documented problem that occurs on a higher rate in preterm children compared to full term children.
  - All preverbal social skills, such as the ability to share attention to an object with another person (i.e., triadic interaction), are suggested to reflect part of the processes through which children learn language 9 (De Schuymera, De Groote, Beyersc, Strianod, Roeyersa, 2011)

RESEARCH IN UK 2006-2011

This research has been founded by BLISS- The premature Baby Charity

Research Aim

To compare the psychological aspects of the effects of premature birth - with and without intermittent KC - with respect to mothers and infants

This research has examined the long term effects, one year, of an early intervention for preterm infants and their parents, which provides skin-to-skin contact in the form of Kangaroo Care (KC) procedure during the infant's hospitalization in high-tech NICUs. The implications of this procedure were explored, looking at:

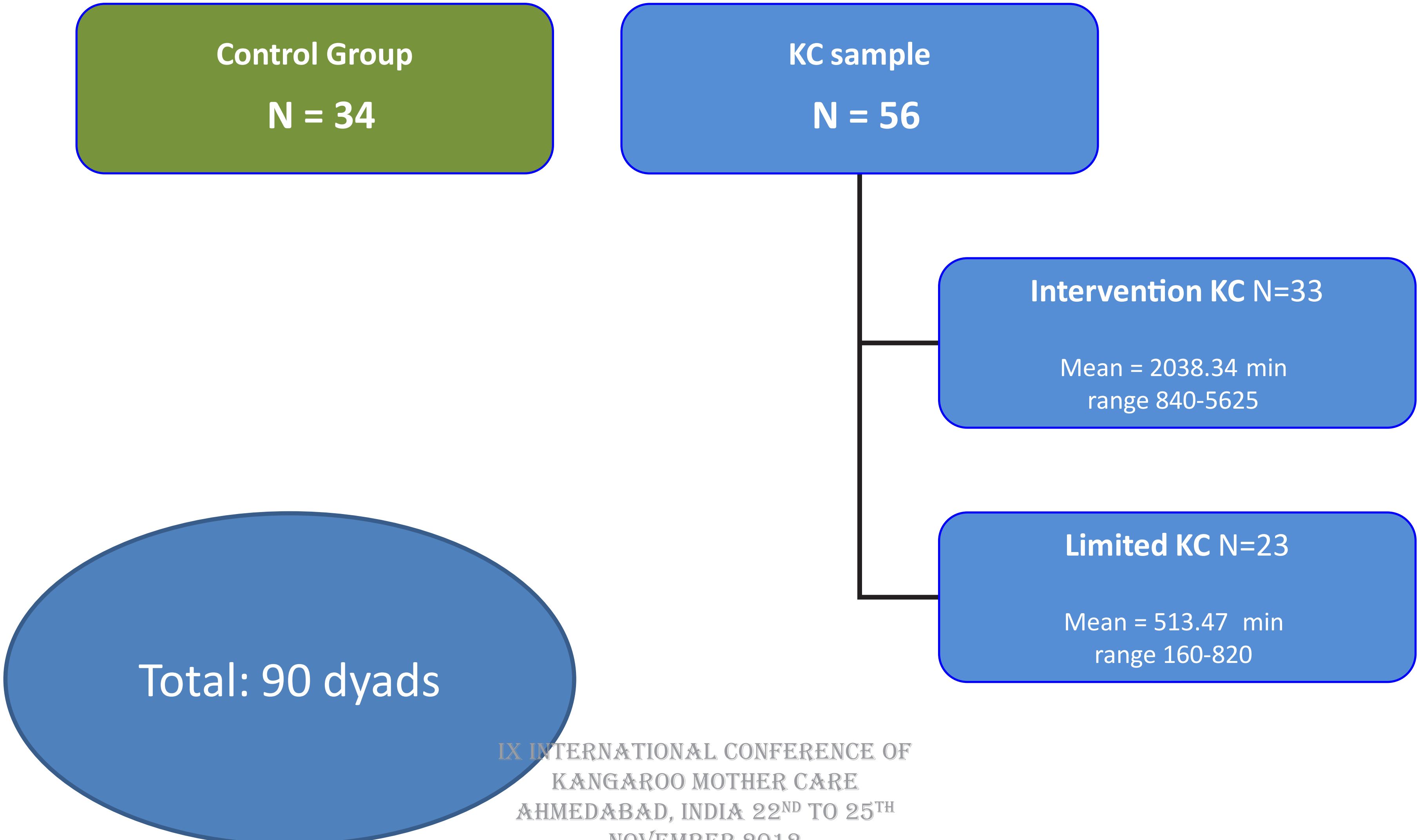
1) parental psychological distress,
2) parental attachment to and representation of their own infant,
3) mother-preterm infant dyadic interaction,
4) infant development
4) infants' proximal environment

Research design:

Pre-post longitudinal clinical control study:

Intermittent Kangaroo Care compared
to
standard-of-care therapy .

6 time points data collection during the first year of the infant's life (Corrected Age).



Control Group
N = 34
KC sample
N = 56
Intervention KC N=33
Mean = 2038.34 min
range 840-5625
Limited KC N=23
Mean = 513.47 min
range 160-820
Total: 90 dyads

KC

Incubator care

Mother visits the child at least once a day

Skin-to-skin contact at least one hour per day

Skin-to-skin contact for at least 14 days

TRADITIONAL CARE

Incubator care with conventional nursing care

Parents invited to visit and touch the child, but no skin-to-skin contact.

KC Initiated between 28° -26 weeks GA (Mean = 32 weeks GA)

KC Intervention Group : N = 33

- at least 60 min per day
- *at least* 14 consecutive days
- Mean 2158,17 minutes (range 880-5625)

Limited KC Group: N = 23

- at least 60 min per day
- *less than* 14 consecutive days
- Mean 478,8 minutes (range 60-820)

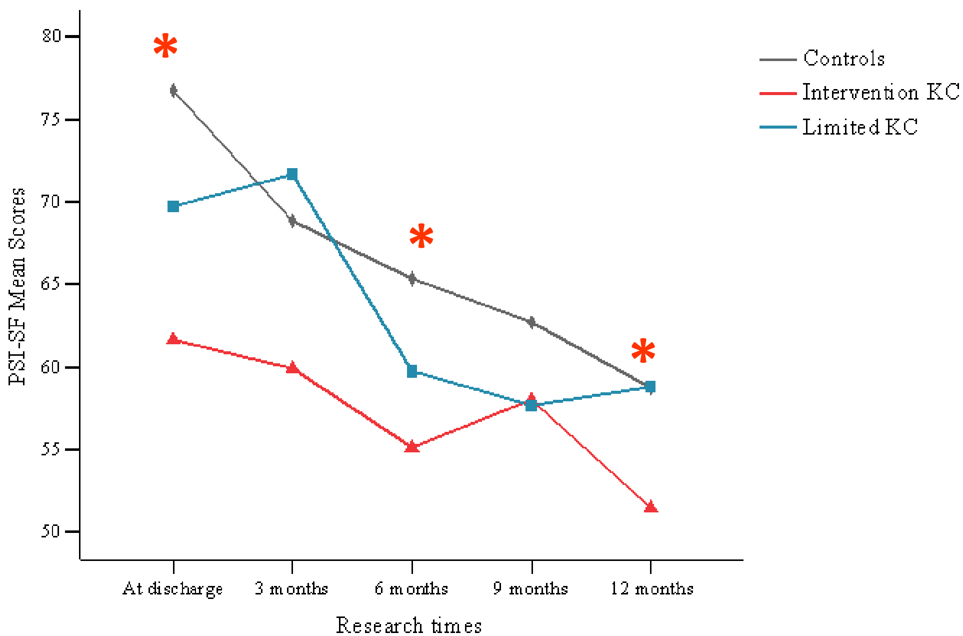
Control Group: N = 34

Analyses

Statistical Analyses: Repeated measures ANCOVAS & MANCOVAS with CRIB II as covariate
Sidak post-hoc comparisons

Results

Mothers' PSI-SF total scores across 12 months



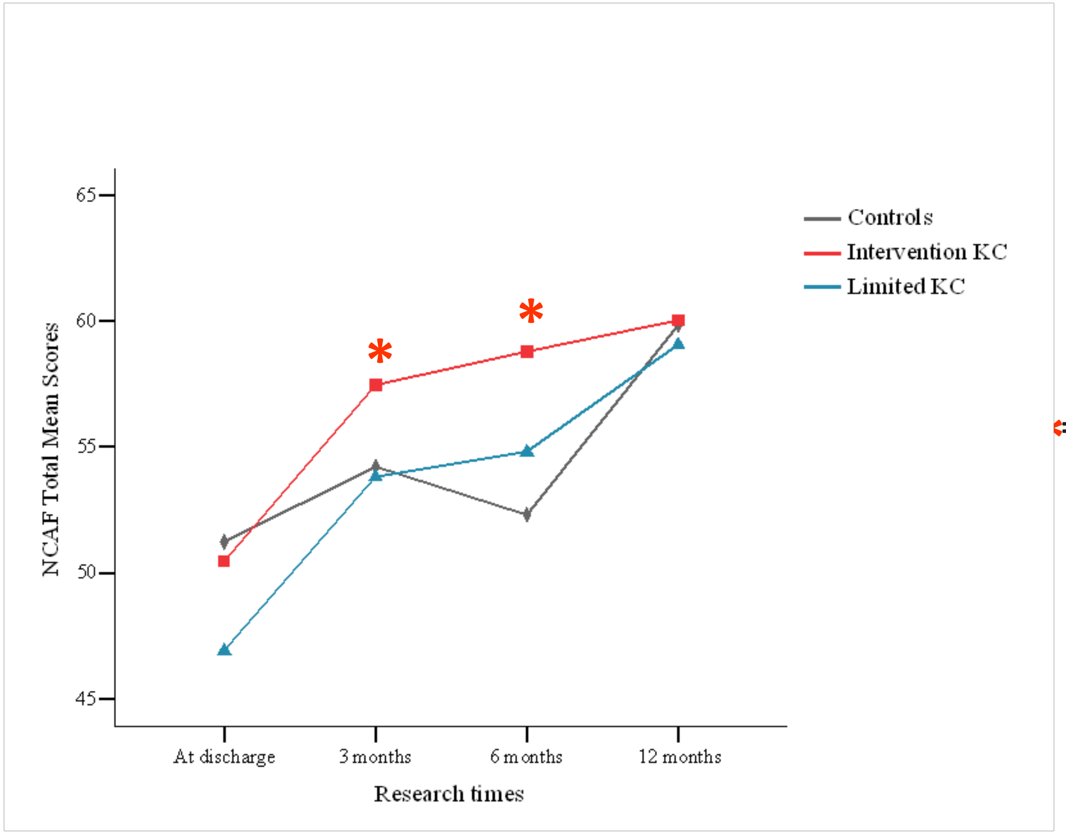
*= p < .05

Results

Mother-infant dyadic interaction scores across 12 months

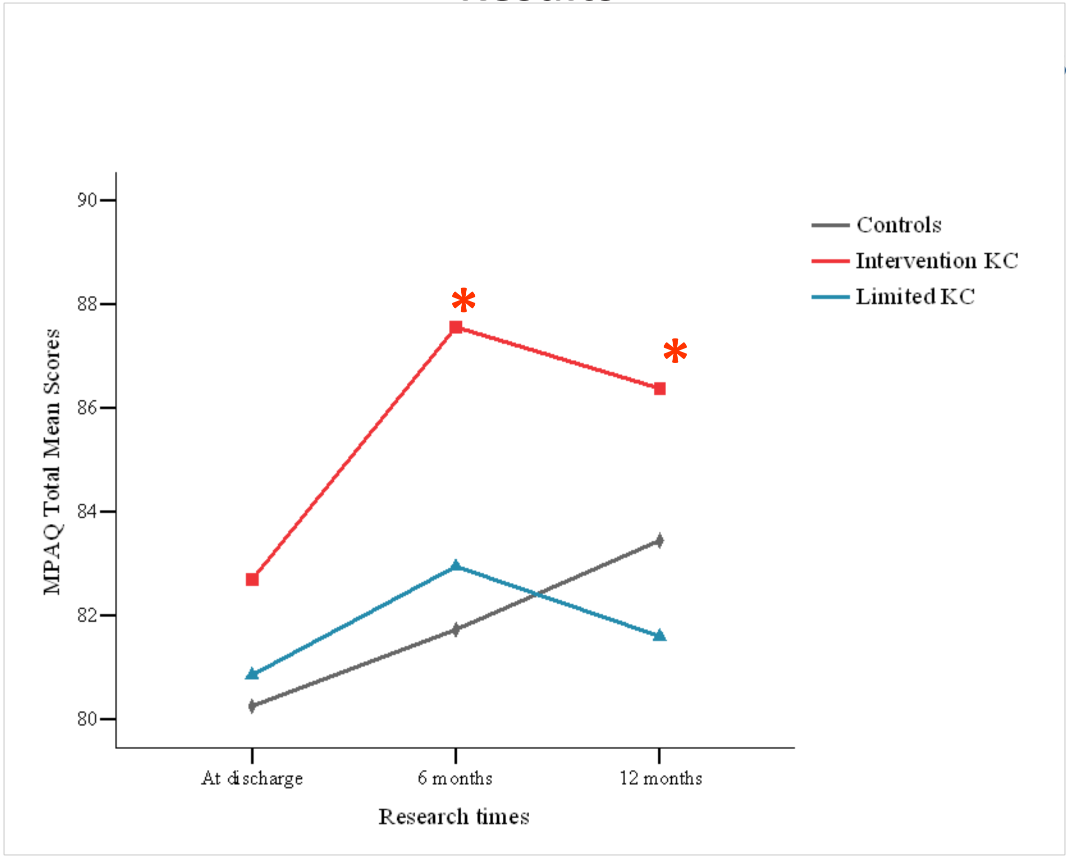
Intervention KC Mothers were better in:
- Responding to the child distress
- Fostering their Cognitive and Socio-emotional growth

Intervention KC Children developed a better capacity to Respond to caregiver



* = p < .05

Results



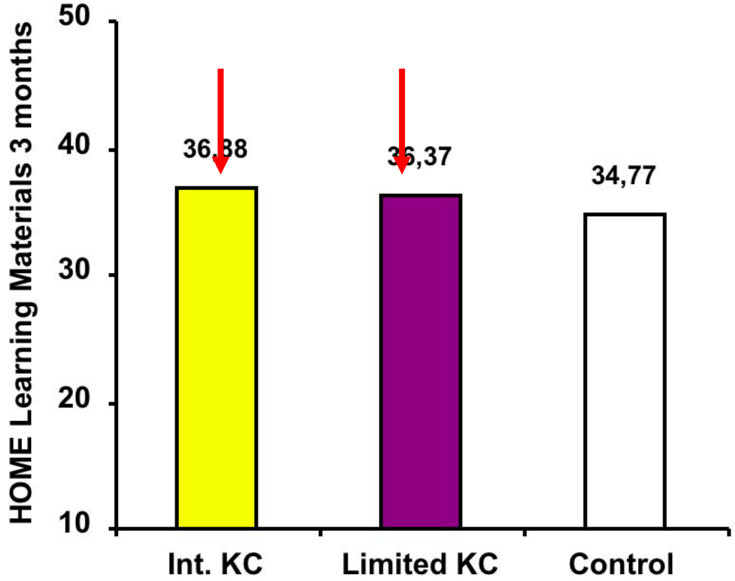
MPAQ Total Mean Scores
90
88
86
84
82
80
At discharge
6 months
12 months
Research times
Controls
Intervention KC
Limited KC
*
*

*= $p < .05$

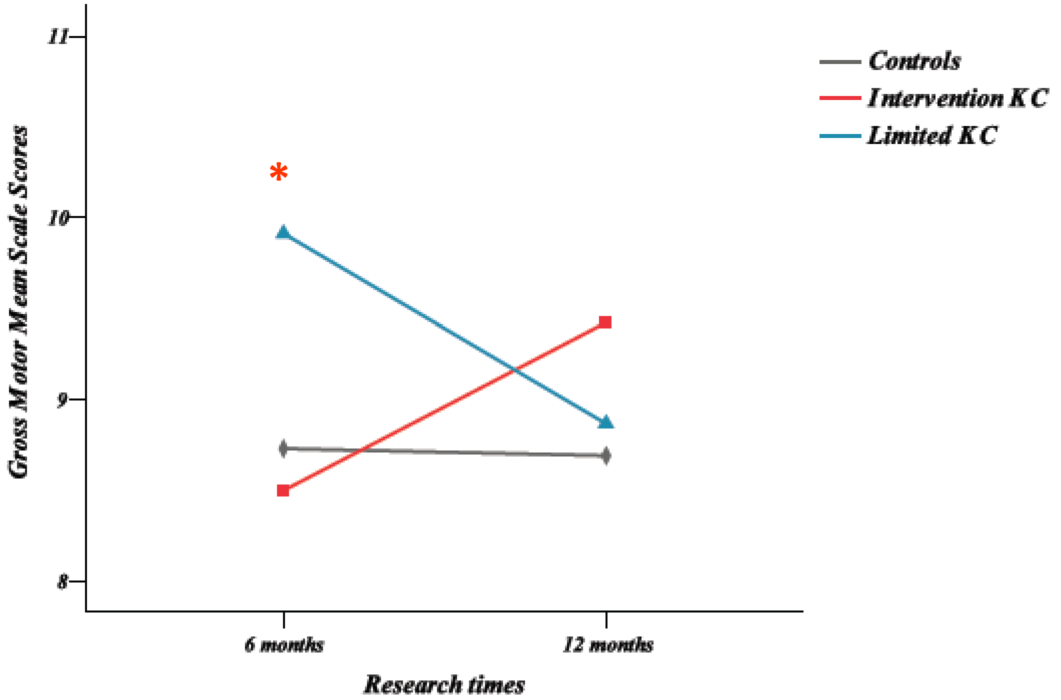
Results

HOME: family environment at 3 months

Learning Materials Scale



* p = .03



Gross motor developmental scores from 6 to 12 months CA

Results

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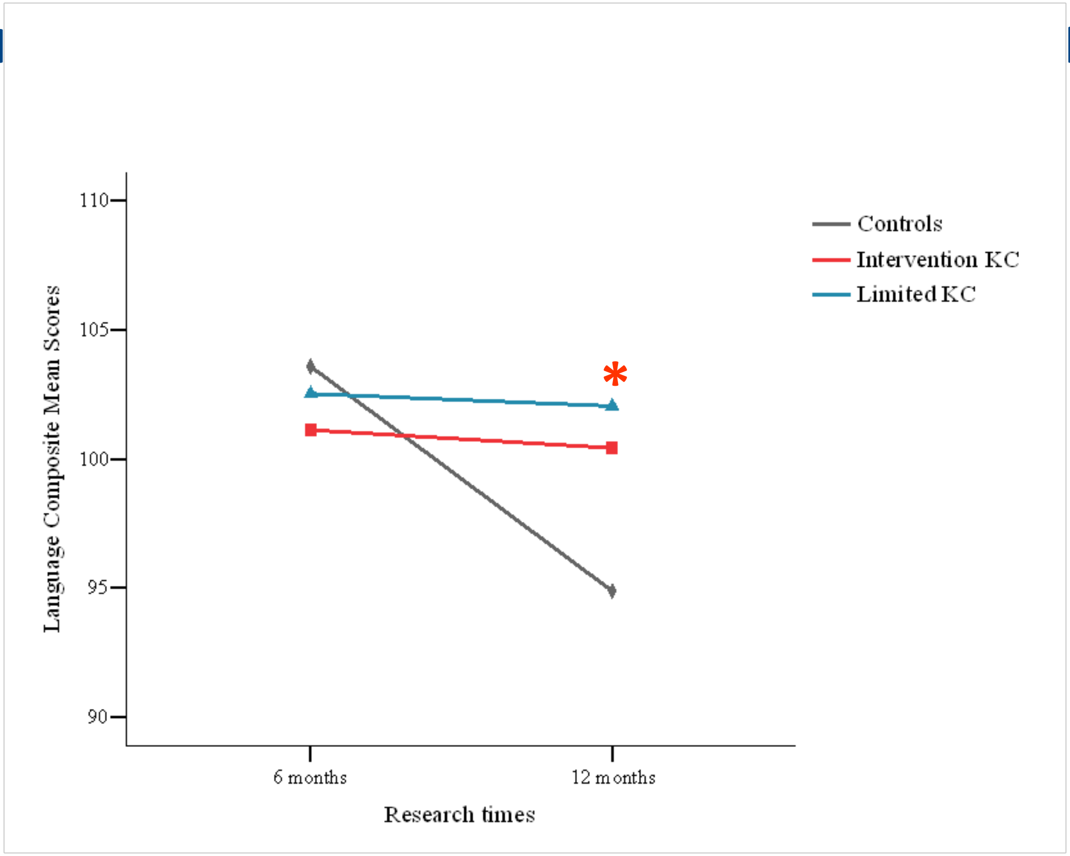
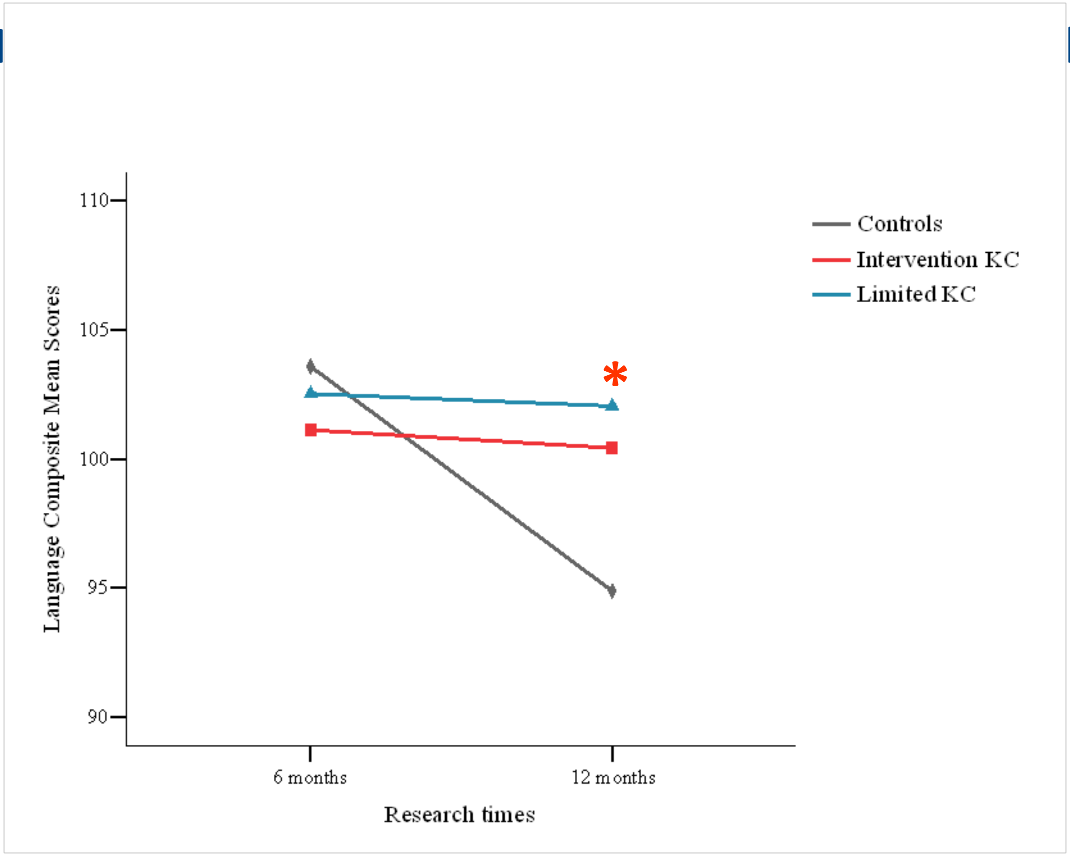


*= p < .05

Results


Language Composite Mean Scores
110
105
100
95
90
6 months
12 months
Research times
Controls
Intervention KC
Limited KC
*

*= p < .05

Results

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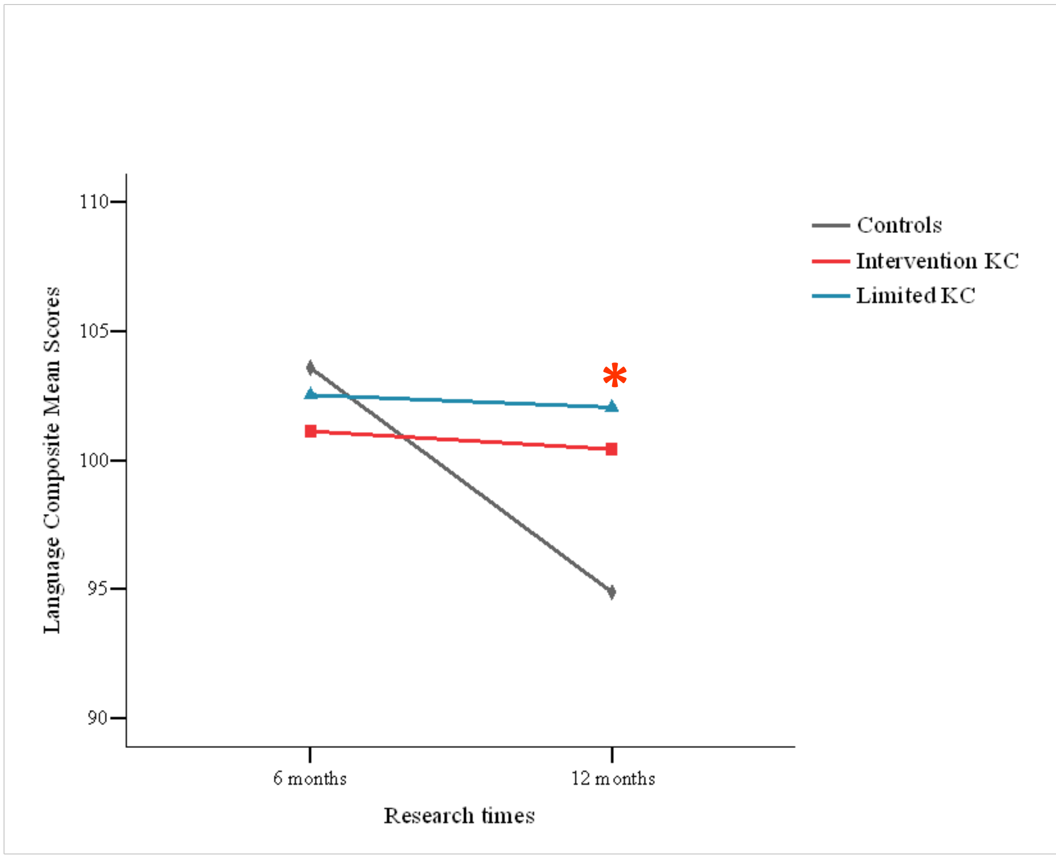


*= p < .05

Predicting Infants' Language Development at 12 months

Models	Predictor variables	B	SE B	β
Step 1	CRIB II	.115	.315	.052
	Family SES	1.38	.946	.208
Step 2	CRIB II	-.037	.322	-.016
	Family SES	1.18	.937	.176
	HOME - Learning Materials (3 months)	-1.64	1.23	-.196
	NCAF – Dyadic Interaction (6 months)	.349	.204	.261
Step 3	CRIB II	[illegible]	.349	-.202
	Family S[illegible]	[illegible]	[illegible]	.248
	HOME - Learning Materials (3 months)	-1.78	1.15	-.214
	NCAF – Dyadic Interaction (6 months)	.204	.202	.152
	Dummy Intervention KC	10.94	4.30	.510*
	Dummy Limited KC	8.50	3.23	.429*

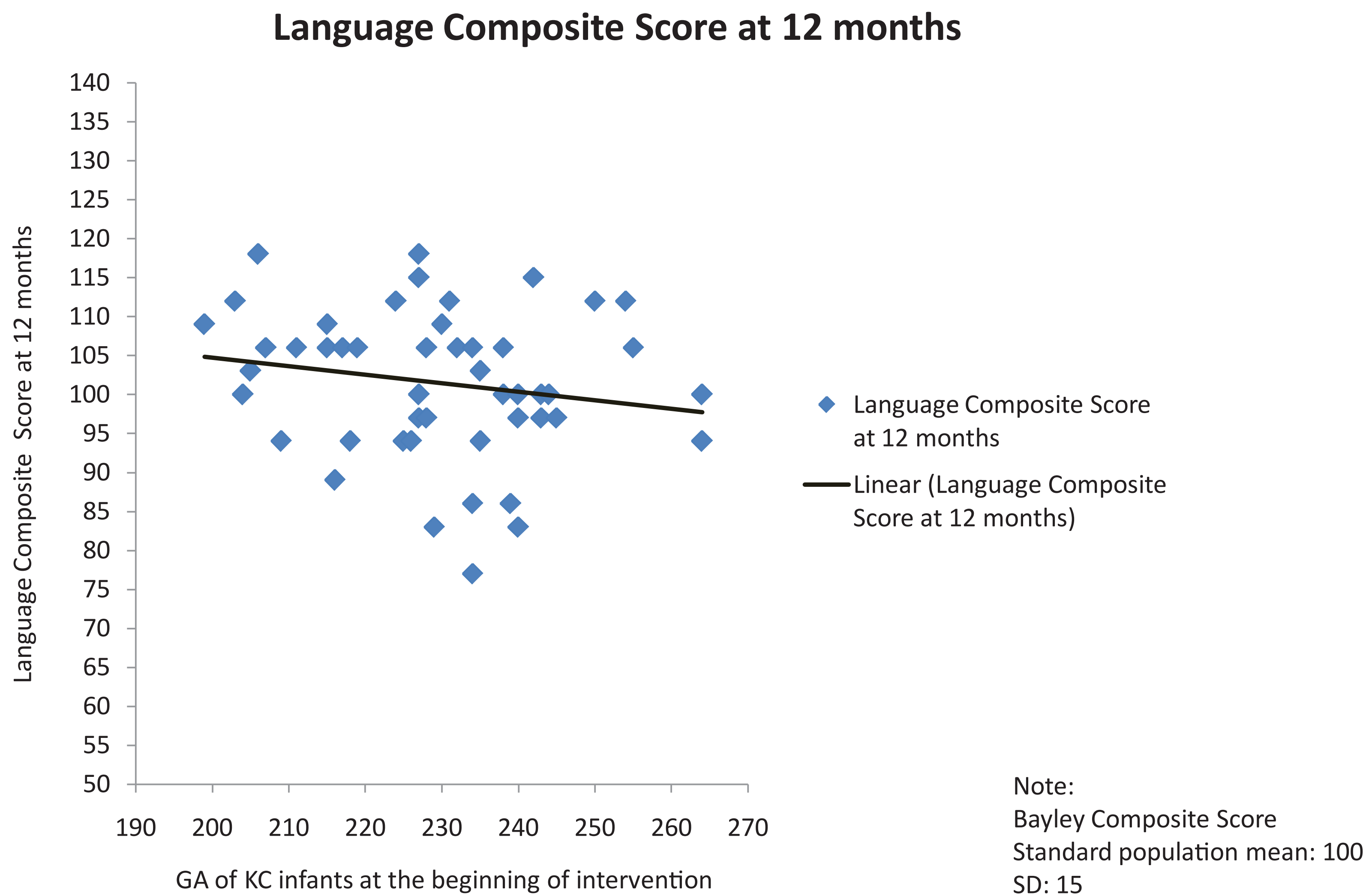
Predicting Infants' Language Development at 12 months

Model 1: R^2 = .044; F (2, 66) = 1.09

Model 2: R^2 = .113; F Change (2, 66) = 1.80; F Model (4, 66) = 1.47

Model 3: R^2 = .255; F Change (2, 66) = 4.20; F Model (6, 66) = 2.51**

** $p < .05$*


Language Composite Score at 12 months
140
135
130
125
120
115
110
105
100
95
90
85
80
75
70
65
60
55
50
Language Composite Score at 12 months
190
200
210
220
230
240
250
260
270
GA of KC infants at the beginning of intervention
Language Composite Score at 12 months
Linear (Language Composite Score at 12 months)
Note:
Bayley Composite Score
Standard population mean: 100
SD: 15

RESEARCH IN ITALY

University of Triest Trieste 2003-2006

This research has been founded by MIUR. Ministery of Education
Regione Friuli Venezia Giulia. FVG

Home environment at 1 year (HOME).

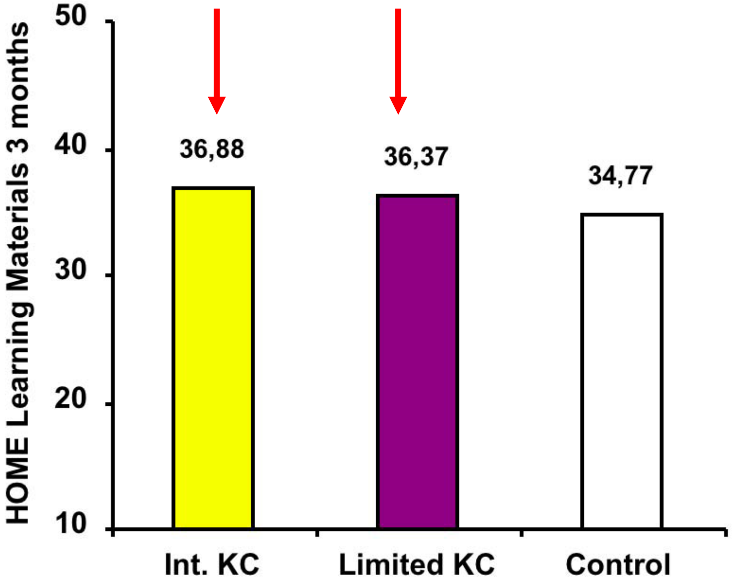
	1 year	KMC N = 27 Mean e DS	TC N = 26 Mean e DS	F	Sig. .05
Total	HOME	42,5 ± 0,6	41,9 ± 0,6	0.06	0.53
Subscale	Mother's emotional and verbal sensitivity	10,0 ± 0,3	10,2 ± 0,3	1.88	0.13
	Punishment: restriction and avoidance	7,2 ± 0,1	7,1 ± 0,1	0.10	0.98
	Physical environment organization	6,0 ± 0,1	5,5 ± 0,1	1.72	0.16
	Appropriate play material supplied	8,9 ± 0,2	8,3 ± 0,2	2.49	0.05
	Mother's involvement with the children	5,7 ± 0,1	5,6 ± 0,1	0.86	0.50
	Appropriate variation in daily stimulation	4,7 ± 0,1	4,6 ± 0,1	4.16	0.01

Ancova with two IV (type of care), five dependent variables (NCAFS scores) and four covariates (infant gender, mother's age, mother's sociability, mother's residence)

Results

HOME: family environment at 3 months

Learning Materials Scale



* p = .03

BAYLEY Scale II

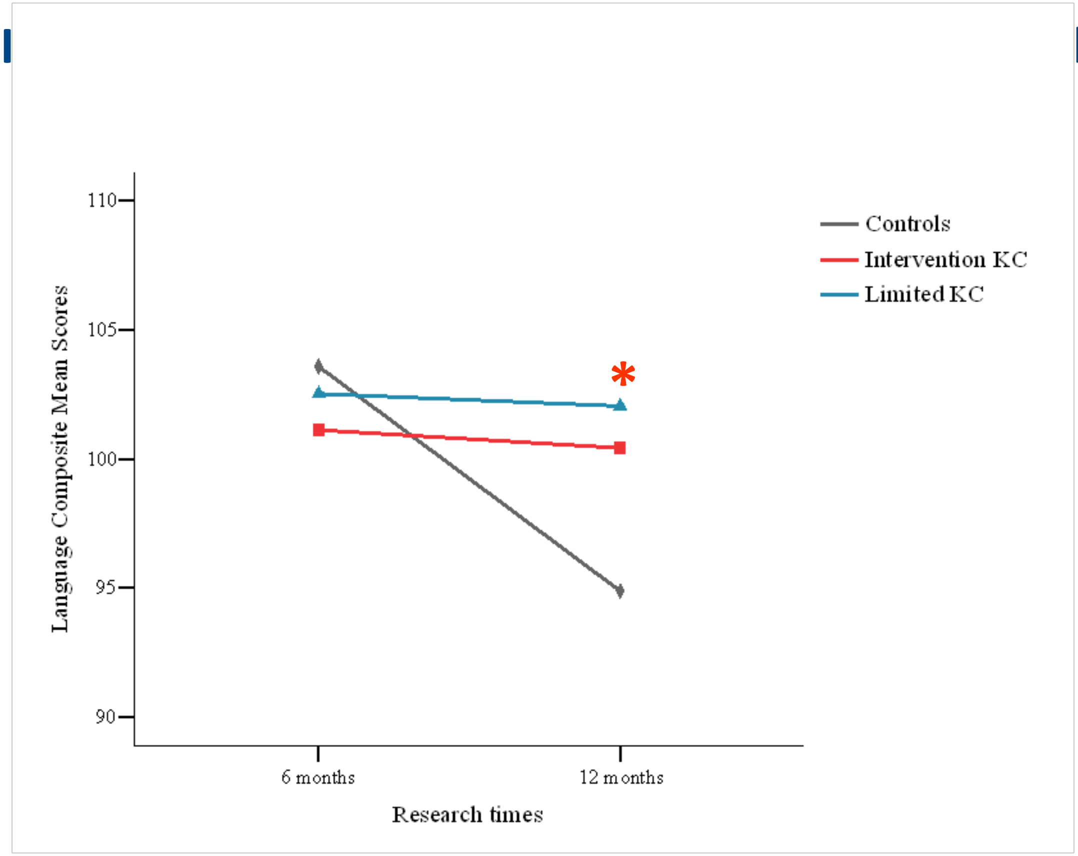
1 year of age	KMC N= 26 Mean e DS	TC N=25 Mean e DS	F	Sig. .05
Mental Developmental Index (MDI)	79,0 ± 3,4	71,6 ± 3,5	3.29	0.05
Psychomotor Developmental Index (MPI)	74,6 ± 3,7	79,7 ± 3,8	0.80	0.46
Behaviour Total	118,17 ± 3,0	113,83 ± 3,0	3.46	0.04
Orientation/Engagement	41,5 ± 1,6	39,3 ± 1,7	1.59	0.21
Emotional Regulation	39,5 ± 1,2	35,1± 1,3	5.28	0.01
Motor Quality	33,9 ± 0,7	34,8± 0,8	1.27	0.29

BAYLEY

Ancova with two IV (type of care), five dependent variables (NCAFS scores) and four covariates (infant gender, mother's age, mother's sociability, mother's residence)

Results

I hs



*= p < .05

Early in life, the brain is particularly plastic, allowing for alternative pathways to form typical behaviour, despite lasting structural deficits (Fox et al. (2010)

Early *enriched* environment, has been shown to greatly improve cognitive, linguistic, and emotional capabilities in humans.

Conclusion

- When early experiences are fraught with threat, uncertainty, neglect or abuse, the developing brain circuitry is disrupted, with a consequently greater level of vulnerability in the child's physical and mental health.
- When early experiences are nurturing, stable, and predictable, healthy brain development is promoted, and other organ regulatory systems are facilitated.

Evidence from neurobiological studies indicates that the longer we wait before investing in children who are at great risk, the more difficult it is to achieve an optimal outcome (Fox et al., 2010; Shonkoff, 2010).

Early intervention in the child's environment is generally considered to play a pivotal role for those children who have experienced early biological disruption and who are the most disadvantaged at the youngest ages;

Experience-dependent mechanisms of brain network formation and maturation may be responsible for such changes when children are placed in a stimulating environment (Fox et al., 2010).

Measures Administered to Participants at Each of the Research Time Point

RESEARCH TIMES	ASSESSMENTS		
	Self-report measures	Observational measures	Development al Scale
Time 1 After physiological stability as been reached	Demographic questionnaire; Infant medical characteristics; GPP-I; BAI; BDI; PSI-SF; NPI; FSS; PAI; EMS		
Time 2 At discharge	BAI; BDI; PSI-SF; NPI; M/PPAQ; FSS; PAI; EMS;	15 minutes videotaped mother-infant interaction during feeding (NCAF)	
Time 3 3 months (CA)	BAI; BDI; PSI-SF; FSS; PAI; EMS; NPI	15 minutes videotaped mother-infant interaction during feeding (NCAF) Home	

Measures Administered to Participants at Each of the Research Time Point

Time 4 6 months (CA)	BAI; BDI; PSI-SF; M/PPAQ	15 minutes videotaped mother-infant interaction during feeding (NCAF)	BSID-III
Time 5 9 months (CA)	BAI; BDI; PSI-SF; FSS	15 minutes videotaped mother-infant interaction during feeding (NCAF)	
Time 6 12 months (CA)	BAI; BDI; PSI-SF; M/PPAQ; FSS; PAI; EMS	15 minutes videotaped mother-infant interaction during feeding (NCAF)	BSID-III

- Much of what we know about the impact of early experience on brain architecture comes from studies of animal and human environmental deprivation (Fox et al., 2010).
- There is compelling evidence from studies of children who have been abused or subjected to chronic neglect in institutionalized settings, which provides support for the theory that significant adversity early in life can induce physiological responses in the service of short term survival benefits. These responses come at considerable cost to long-term adaptive capacities as well as to both physical and mental health (Cicchetti, Rogosch, Gunnar, & Toth, 2010; Pollak, Nelson, Schllak, Roeber, Wewerka, Wilk, et al., 2010).

- A longitudinal study, the Bucharest Early Intervention Project (BEIP), followed three groups of children: an Institutionalised group, children who have lived virtually all their lives in an institutional setting in Bucharest, Romania; a Foster Care group, which includes children who were institutionalised at birth and subsequently placed in foster care; and a Never Institutionalised group, which includes children living with their biological families in the Bucharest region. When the children in the foster group received high-quality foster care
- before the age of 2, it led to a dramatic increase in IQ (Nelson, Zeanah, Fox, Marshall, Smyke, & Guthrie, 2007) and to greater language skills compared to those children who were placed in foster care after they turned 2 years old. Their skills of the Foster Care children were more similar to those children who had never been institutionalised (Windsor, Glaze, Koga, & the BEIP Core Group, 2007).

The presence of a specialised network in the "social brain"

Johnson (2005) hypothezied the existence of an interactive specialization: there is a pre-disposition at birth

but

the interaction with the social environment is indispensable in order to reach a complete and specific maturation of neural connexions.

All relationships modifications, in quality and quantity, leave lasting and deep traces in developmental processes.

- Experience-dependent mechanisms of brain network formation and maturation may be responsible for such changes when children are placed in a stimulating environment (Fox et al., 2010).
- Enrichment may lead to a restoration of typical development through the use of a growth-facilitating interpersonal environment.
- In conclusion, when early experiences are nurturing, stable, and predictable, healthy brain development is promoted, and other organ regulatory systems are facilitated.
- When, on the other hand, early experiences are fraught with threat, uncertainty, neglect or abuse, the developing brain circuitry is disrupted, with a consequently greater level of vulnerability in the child's physical and mental health.

Recent approaches to the assessment of child development in early childhood requires a careful examination of:

-individual characteristics of child development

-the personality profile of the caregiver.

-an analysis of the general context

↓

multifactorial evaluation

High prevalence/low severity **language** delay in preschool children born very **preterm**.

Foster-Cohen SH; Friesen MD; Champion PR; Woodward LJ Author : [J Dev Behav Pediatr] Journal Of Developmental And Behavioral Pediatrics: JDBP 2010 Oct; Vol. 31 (8), pp. 658-67.

Illness Index ; Social Environment Abstract: **Objective:** To examine the **language development** at corrected age 4 years of a regionally representative cohort of children born very **preterm** (VPT). Of particular interest was the identification of biological and socioenvironmental risk and protective factors that influence VPT children's early **language development**.

Method: Data were collected as part of a prospective longitudinal study of 110 VPT (VPT:≤ 33 weeks gestation) and 113 full-term children (full term: 37-41 weeks gestation) born in Canterbury, New Zealand from 1998 to 2000. At corrected age 4 years, all children were assessed with the preschool version of the Clinical Evaluation of **Language** Fundamentals. Extensive information was also collected about children's family social background, perinatal health, childrearing environment, education/intervention exposures, and neurodevelopmental progress from birth to age 4.

Results: At the age of 4 years, VPT children were characterized by poorer receptive and expressive **language development** than full-term children. These differences persisted after exclusion of children with neurosensory impairment as well as statistical adjustment for the effects of social risk. Within the VPT group, the key predictors of children's overall **language development** were family social risk at birth (p =.05), severity of white matter abnormalities on neonatal magnetic resonance imaging (p =.49), observed parent-child synchrony (p =.001), and concurrent child cognitive ability (p =.001). Together, these factors accounted for 45% of the variance in children's total Clinical Evaluation of **Language** Fundamentals-Preschool scores.

Conclusion: By preschool age, children born VPT show early emerging mild to moderate **language** delays that are likely to affect their school success and longer-term developmental progress. Findings highlight the importance of potentially modifiable factors such as early **brain** injury and parenting quality in predicting the **language** outcomes of children born VPT. Foster-Cohen SH; Friesen MD; Champion PR; Woodward LJ Author : Entry Dates: *Date Created:* 20101006 *Date Completed:* 20110202 Update Code: 20111122

- Language Development and The Brain Mechanisms of Preterm Children
  Authors: Chen, YX
  Zhu, LQ **Source:** *PROGRESS IN BIOCHEMISTRY AND BIOPHYSICS*; OCT, 2011, 38 10, p884-p890, 7p. **Publisher Copyright:** CHINESE ACAD SCIENCES, INST BIOPHYSICS **ISSN:** 10003282
  Abstract: Language development in preterm children is quite special. Behavioral studies found that preterm children were lagging behind their full term peers in areas such as vocabulary, syntax, and semantic verbal fluency. The effect of preterm birth on language development may last till early adulthood, and the degrees of such lags were influenced by biological and social factors. With the development of brain imaging, studies began to examine the brain development of premature children. Researchers have found group differences in white matter (WM) structures, subcortical gray matter (GM), and the cerebellum among preterm adolescents and their full term peers; yet the brain mechanism of language development in preterm children needs further researches to confirm. The paper describes the latest progress of behavior and neuron studies on preterm children's language development, thus to explore the law of language development and cognitive neuroscience mechanism in preterm children. Research suggests that behavior study and brain research should be combined to extend their advantages, thus to explore the mechanism of the language development of premature children, and to provide unique evidence of language acquirement of normal children.

- Neonatal pain, parenting stress and interaction, in relation to cognitive and motor development at 8 and 18months in preterm infants **Authors:** Ruth E. Grunaua, b, c,
  Michael F. Whitfielda, b, c
  Julianne Petrie-Thomasc
  Anne R. Synnesb, c
  Ivan L. Cepedaa
  Adi Keidara
  Marilyn Rogersc
  Margot MacKayc
  Philippa Hubber-Richardc
  Debra Johannesenc 10.1016/j.pain.2009.02.014
- **bstract:** Procedural pain in the neonatal intensive care unit triggers a cascade of physiological, behavioral and hormonal disruptions which may contribute to altered neurodevelopment in infants born very preterm, who undergo prolonged hospitalization at a time of physiological immaturity and rapid brain development. The aim of this study was to examine relationships between cumulative procedural pain (number of skin-breaking procedures from birth to term, adjusted for early illness severity and overall intravenous morphine exposure), and later cognitive, motor abilities and behavior in very preterm infants at 8 and 18months corrected chronological age (CCA), and further, to evaluate the extent to which parenting factors modulate these relationships over time. Participants were N=211 infants (n=137 born preterm 32weeks gestational age [GA] and n=74 full-term controls) followed prospectively since birth. Infants with significant neonatal brain injury (periventricular leucomalacia, grade 3 or 4 intraventricular hemorrhage) and/or major sensori-neural impairments, were excluded. Poorer cognition and motor function were associated with higher number of skin-breaking procedures, independent of early illness severity, overall intravenous morphine, and exposure to postnatal steroids. The number of skin-breaking procedures as a marker of neonatal pain was closely related to days on mechanical ventilation. In general, greater overall exposure to intravenous morphine was associated with poorer motor development at 8months, but not at 18months CCA, however, specific protocols for morphine administration were not evaluated. Lower parenting stress modulated effects of neonatal pain, only on cognitive outcome at 18months.

Sample

Preterm infants and their parents were recruited in the selected hospitals between June 2006 and August 2008. Infants born at less than 37 gestational weeks (GA) and 2000 grams, who reached physiological stability, as decided by the medical team, were eligible for recruitment. Infants with major congenital malformations were excluded from the study, as were cases with any parental psychopathological history and/or any ongoing family social issues. The latter could in fact impinge on the psychological and behavioural variables investigated.

A power analysis calculated a sample size of 125 subjects, in order to detect differences between groups in relation to our primary outcome with an alpha of .05 and a beta of .08, estimating an effect size of medium magnitude equivalent to ω2A of .05. Five hundred and sixty six (566) children of less then 2000 grams and less then 37 weeks of gestation were born during this period. Of these 267 (47,17%) were eligible to be approached. Two hundred and thirty eight (238) were approached and a total of 135 were recruited following consecutive admission to the NICU. The remaining 109 refused to take part in the research (see Figure 3.1). Twenty-nine (29) families were not approached even if eligible because of logistical problems.

- The following between-group variables were controlled for infants: gender, parity, singleton versus twins, and medical risk (CRIB II).
- Family between-group control variables were: maternal and paternal age at infant birth, education, ethnicity, occupation, socio-economic status, number of children and mothers' personality characteristics. The latter control variable was necessary in order to exclude any personal characteristic bias in the mother's choice to provide Kangaroo Care to their newborn. Participants were assessed using a questionnaire to collect parental demographic information and infant medical characteristics

The results show that the infants' health status did not influence the family's participation: no significant differences existed between the two groups in relation to the infants' birth gestational age, weight, Apgar score at 5 minutes and medical risk (CRIB II) at the entry of the trial. However, the following differences were found in relation to demographic variables: maternal age, $F (1, 134) = 9.23$; $p = .003$, marital status, 2 (2, 134) = 10.65; $p = .005$, mother's occupation, 2 (3, 134) = 16.16; $p = .001$, and family socio- economic status, 2 (7, 134) = 27.78; $p < .001$. As illustrated in Table 1 and 2, the results indicate that those mothers who dropped out of the research group tended to be younger, single, with a higher percentage of unemployment and lower economic status than the mothers who participated.

- Moreover, parental personality characteristics were evaluated administering a standardised questionnaire (GPP-I, Gordon, 1993; see the measure section below for a full description). Socio-economic status was computed using the UK National Statistic Socio-Economic Classification (NS- SEC, 2001). Finally, infant neonatal risk was evaluated using the Clinical Risk Index for Babies (CRIB II) (Parry, 2003), which is calculated by compounding the influence of GA, birth temperature, worst base excess in the first 12 hours of life, and gender. Mettere una delle diapo comn il flow chart dei tests

- The homogeneity between the group of families who dropped out of the research at the

- infant's discharge from hospital (at Time 2) and the families who participated in the

- remaining research times has been investigated through an examination of the families'
- demographic characteristics and the infants' medical condition at birth.

The aim was to answer some specific questions: whether KC applied alongside incubator care in a High-tech NICU promotes the formation of the parent-infant relationship and of bonding, and whether KC has an effect on the specific areas investigated, across the first year of the infants' life. Three groups were compared: Intervention KC, where mothers provided skin-to-skin contact to their infant, Limited KC, where a lower amount of KC was provided and the Control group.

….. . …. When the baby is preterm

- H/S watches the mother less than a full term baby
- H/S vocalizes and smiles very little
- H/S does not clearly communicate h/h needs
- H/H interactive capacities are very limited
  therefore
- The interactive process can be damaged
- The developmental processes in general can be damaged
- The language development can be damaged
- The motor development can be damaged

- …….

This study has demonstrated the positive impact of KC intervention on maternal stress, on the mothers' attachment towards their infants, on the mother-infant dyadic interaction, on the infants' home environment and on the infants' gross motor, language and adaptive behaviour development. Moreover, Figure 4.12 provides a visual representation of the predictive power of the KC intervention in relation to its long-term effects on motherinfant
dyadic interaction, maternal attachment, parenting stress and language development.
This study has also established that the efficacy of KC was stronger when mothers followed the recommended structured implementation (at least 1 hour per day for 14 consecutive days).

Pregnancy, Premature Infants, Neurology, Children, Brain, Body Weight, Child Development, Adolescent Development, Literature Reviews, Comparative Analysis, Meta Analysis, Cognitive Ability, Age Differences

Abstract: Aim: The aim of this article was to clarify the impact and consequences of very preterm birth (born less than 32wks of gestation) and/or very low birthweight ([VLBW], weighing less than 1500g) on brain volume development throughout childhood and adolescence. Method: The computerized databases PubMed, Web of Knowledge, and EMBASE were searched for studies that reported volumetric outcomes during childhood or adolescence using magnetic resonance imaging and included a term-born comparison group. Fifteen studies were identified, encompassing 818 very preterm/VLBW children and 450 term-born peers. Average reductions in the total brain volume, white matter volume, grey matter volume, and in the size of the cerebellum, hippocampus, and corpus callosum were investigated using meta-analytic methods. Results: Very preterm/VLBW children were found to have a significantly smaller total brain volume than the comparison group (d = -0.58; 95% confidence interval [CI] -0.43 to -0.73; p less than 0.001), smaller white matter volume (d = -0.53; CI -0.40 to -0.67; p less than 0.001), smaller grey matter volume (d = -0.62; CI -0.48 to -0.76; p less than 0.001), smaller cerebellum (d = -0.74; CI -0.56 to -0.92; p less than 0.001), smaller hippocampus (d = -0.47; CI -0.26 to -0.69; p less than 0.001), and smaller corpus callosum (d = -0.71; CI -0.34 to -1.07; p less than 0.001). Reductions have been associated with decreased general cognitive functioning, and no relations with age at assessment were found. Interpretation: Very preterm/VLBW birth is associated with an overall reduction in brain volume, which becomes evident in equally sized reductions in white and grey matter volumes, as well as in volumes of

diverse brain structures throughout childhood and adolescence.

- This study investigates the Third Edition of the Bayley Scales of Infant and Toddler Development (Bayley-III) and: (1) early patterns of neurodevelopmental performance among preterm infants 8–12 months of age; and (2) correlations between known risk factors and neurodevelopmental outcome of preterm infants in this cohort. Mean Language Index (LI; 91±15) and Motor Index (MI; 94±17) were significantly lower than the Cognitive Index (CI; 102±15, p<.01). For the majority (53%) of infants, language development was their weakest domain; for another 39%, motor skills were the weakest area of development. Almost one-quarter (22%) of this cohort had mildly delayed language and motor skills, while 7% had significantly delayed language and motor skills. Regression models revealed severely abnormal head ultrasound significantly predicted MI, LI, and CI. Oxygen dependence at discharge predicted CI, LI, and race/ethnicity predicted LI, MI. Results support the addition of the Language Index to the newly revised Bayley-III Scales. Prediction models of developmental performance confirm known neonatal risk factors and reveal sociodemographic risk factors that call for additional research.

Language delay is a well documented problem that occurs on a higher rate in preterm children compared to full term children. Preverbal social skills, such as the ability to share attention to an object with another person (i.e., triadic interaction), are suggested to reflect part of the processes through which children learn language. This longitudinal study examined preverbal and verbal skills in 25 preterm and 35 full term children in order to investigate if birth status affects language development through the proposed mediating processes of preverbal dyadic and triadic skills. Dyadic initiatives during the still-face episode were assessed at 6months. Triadic responsiveness (gaze following) was examined at 9 and 14months. Triadic initiatives (joint attention and behavioral request) were also assessed at 14months. At 30months, receptive and expressive language was examined. The data showed group differences in 6-month dyadic initiatives, 9-month triadic responsiveness, 14-month triadic behavioral request initiatives and 30-month receptive and expressive language skills at the expense of the preterm children, confirming their risk for a less favorable preverbal and verbal development. Multiple mediation analyses confirmed the hypothesis that birth status affects language development partially through preverbal skills, which is important for clinical practice.

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Aim: The aim of this article was to clarify the impact and consequences of very preterm birth (born less than 32wks of gestation) and/or very low birthweight ([VLBW], weighing less than 1500g) on brain volume development throughout childhood and adolescence. Method: The computerized databases PubMed, Web of Knowledge, and EMBASE were searched for studies that reported volumetric outcomes during childhood or adolescence using magnetic resonance imaging and included a term-born comparison group. Fifteen studies were identified, encompassing 818 very preterm/VLBW children and 450 term-born peers. Average reductions in the total brain volume, white matter volume, grey matter volume, and in the size of the cerebellum, hippocampus, and corpus callosum were investigated using meta-analytic methods. Results: Very preterm/VLBW children were found to have a significantly smaller total brain volume than the comparison group (d = -0.58; 95% confidence interval [CI] -0.43 to -0.73; p less than 0.001), smaller white matter volume (d = -0.53; CI -0.40 to -0.67; p less than 0.001), smaller grey matter volume (d = -0.62; CI -0.48 to -0.76; p less than 0.001), smaller cerebellum (d = -0.74; CI -0.56 to -0.92; p less than 0.001), smaller hippocampus (d = -0.47; CI -0.26 to -0.69; p less than 0.001), and smaller corpus callosum (d = -0.71; CI -0.34 to -1.07; p less than 0.001). Reductions have been associated with decreased general cognitive functioning, and no relations with age at assessment were found. Interpretation: Very preterm/VLBW birth is associated with an overall reduction in brain volume, which becomes evident in equally sized reductions in white and grey matter volumes, as well as in volumes of diverse brain structures throughout childhood and adolescence.

Procedural pain in the neonatal intensive care unit triggers a cascade of physiological, behavioral and hormonal disruptions which may contribute to altered neurodevelopment in infants born very preterm, who undergo prolonged hospitalization at a time of physiological immaturity and rapid brain development. The aim of this study was to examine relationships between cumulative procedural pain (number of skin-breaking procedures from birth to term, adjusted for early illness severity and overall intravenous morphine exposure), and later cognitive, motor abilities and behavior in very preterm infants at 8 and 18months corrected chronological age (CCA), and further, to evaluate the extent to which parenting factors modulate these relationships over time. Participants were N=211 infants (n=137 born preterm   32weeks gestational age [GA] and n=74 full-term controls) followed prospectively since birth. Infants with significant neonatal brain injury (periventricular leucomalacia, grade 3 or 4 intraventricular hemorrhage) and/or major sensori-neural impairments, were excluded. Poorer cognition and motor function were associated with higher number of skin-breaking procedures, independent of early illness severity, overall intravenous morphine, and exposure to postnatal steroids. The number of skin-breaking procedures as a marker of neonatal pain was closely related to days on mechanical ventilation. In general, greater overall exposure to intravenous morphine was associated with poorer motor development at 8months, but not at 18months CCA, however, specific protocols for morphine administration were not evaluated. Lower parenting stress modulated effects of neonatal pain, only on cognitive outcome at 18months.

Low-frequency oscillations in cerebral blood flow that are suggestive of resting-state brain activity have recently been reported, but no study on the development of resting-state brain activity in preterm infants has been performed. The objective of this study was to measure the cerebral blood flow oscillations, which are assumed to represent brain function in the resting state, in preterm and term infants of the same postconceptional age. The subjects were 9 preterm infants who had reached full term (gestational age (GA): 23–34weeks, postconceptional age: 37–46weeks) and 10 term infants (GA: 37–40weeks, postconceptional age: 37–41weeks). Their changes in concentration of oxyhemoglobin ([oxyHb]) and deoxyhemoglobin ([deoxyHb]) were measured in the parieto-temporal region during quiet sleep using multi-channel near-infrared spectroscopy, and the power spectral densities (PSD) of the oscillations in the concentrations of these molecules were analyzed and compared. The preterm infants displayed a higher proportion of 0.06–0.10Hz low frequency oscillations of [oxyHb] and [deoxyHb] than the term infants, and the gestational age and the proportion of low frequency oscillations were inversely correlated. These findings suggest that resting-state cerebral blood flow oscillations differ between preterm and term infants, and that the development of circulatory regulation and nerve activity in preterm infants are influenced by the extrauterine environment.

Neonatal Intensive Care Unit

Temporary separation of the infant from his/her mother

Primary care of the baby is transferred to the professional providers from the mother

Limitation of crucial physical and psychological aspects of infant-parent contact

Disruption of parent-infant reciprocal bonding

Risk of parenting disorder

Specific Aims

- **To investigate the psychological impact of KC on single infants and twins regarding:**
  - **Maternal anxiety**
  - **Infants' interactive signals**
  - **Mother-infant relationship**

Secondary and long-term aims:

- **To find if there are maternal psychological characteristics that favour the KC Procedure**
- **To verify KMC long-term effect at 3, 6, and 12 months**

Groups were similar (p > .05) for:

Gestational age; weight at birth; type of delivery; sex; Apgar 1 min.; Apgar 5 min;

Mother's age; mother's education; mother's occupation; medical checks, mother's personality characteristics.

Father's education; father's occupation; father's age;

Presence of both parents.

Maternal personality characteristics Gordon (Anova)

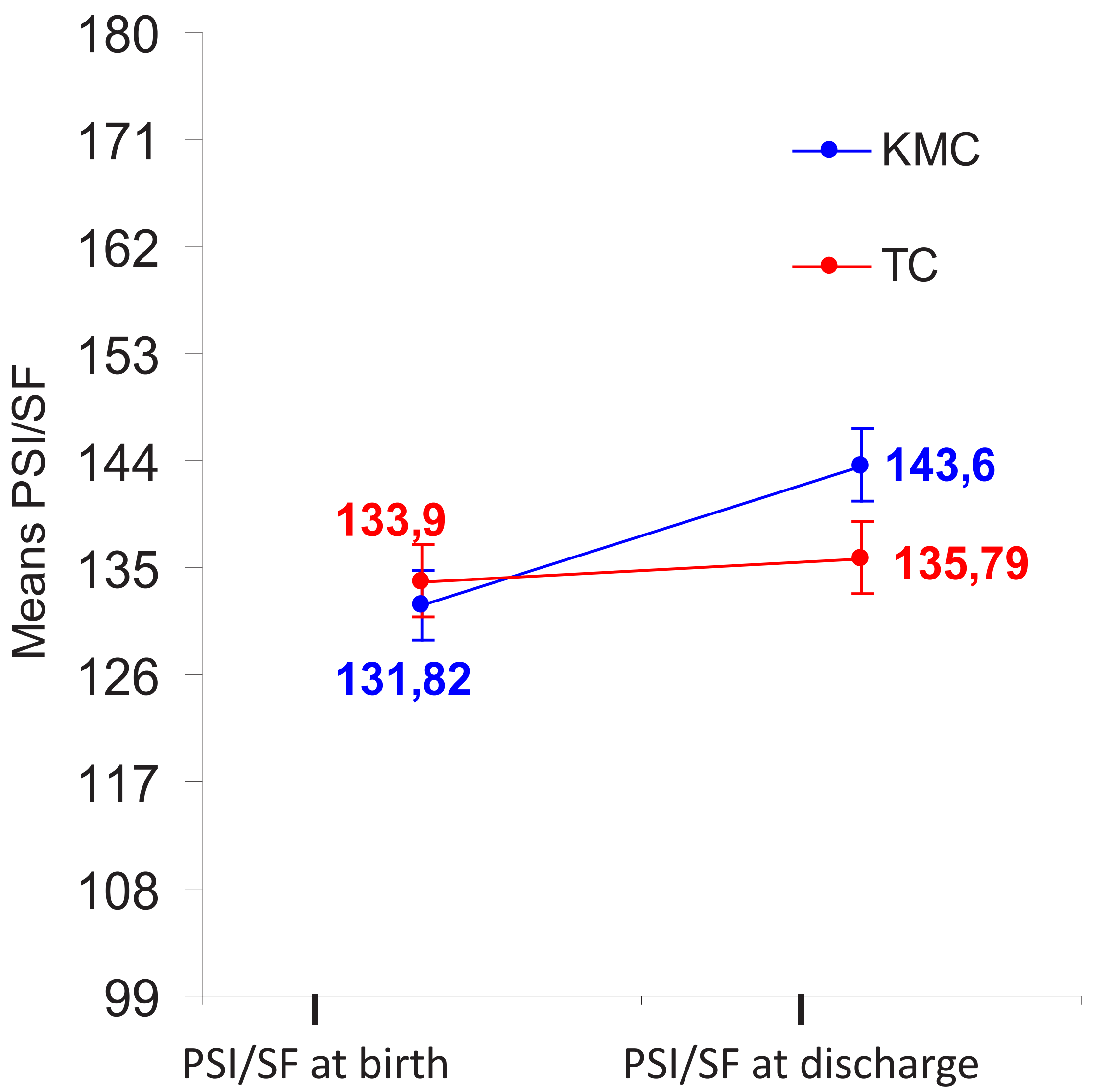
	KMC N= 40	TC N=42	F	Sig.
	Mean &SD	Mean & SD		.05
Ascendency	52,73 ± 30,087	54,60 ± 28,004	0.049	0.826
Responsibility	70,05 ± 26,786	73,48 ± 27,126	0.190	0.665
Emotional stability	66,18 ± 24,377	58,24 ± 27,866	1.067	0.307
Sociability	43,32 ± 25,674	58,32 ± 28,231	3.595	0.064
Self-esteem	60,68 ± 28,997	63,12 ± 30,741	0.078	0.782
Caution	64,36 ± 25,205	62,76 ± 25,523	0.047	0.830
Original thought	48,05 ± 29,538	50,88 ± 33,714	0.093	0.762
Personal relationships	62,36 ± 28,337	54,40 ± 29,679	0.879	0.354
Vigour	65,86 ± 27,691	58,36 ± 27,936	0.851	0.361

Stress at birth

		KMC N= 40 Mean & SD	TC N=42 Mean & SD	F	Sig. .05
Total	Parent Stress Index	131,82 ± 15,739	133,90 ± 14,557	0.383	0.538
Subscales	Parental Distress	46,15 ± 5,060	46,71 ± 4,587	0.273	0.603
	Parent Child Dysfunctional Interaction	45,46 ± 7,085	46,26 ± 6,382	0.286	0.594
	Difficult Child	40,21 ± 6,590	40,93 ±5,615	0.284	0.596
	Defensive Responding	27,67 ± 3,489	27,38 ±2,723	0.170	0.681

Stress at discharge (Anova)

		KMC N= 40 Mean & SD	TC N=42 Mean & SD	F	Sig. .05
Total	Parent Stress Index	143,60 ± 13,619	135,79 ± 16,153	5.582	0.020
Subscales	Parental Distress	46,68 ± 5,595	45,17 ± 7.115	6.120	0.010
	Parent Child Dysfunctional Interaction	50,43 ± 5,420	46,05 ± 7,050	9.865	0.002
	Difficult Child	44,55 ± 6,361	43,67 ± 6,599	0.380	0.540
	Defensive Responding	28,65 ± 3,215	26,83 ± 3,741	5.537	0.020



180
171
162
153
144
135
126
117
108
99
Means PSI/SF
KMC
TC
133,9
131,82
143,6
135,79
PSI/SF at birth
PSI/SF at discharge

Interaction at discharge

		KMC N= 40 Mean & SD	TC N=42 Mean & SD	F	Sig. .05
Total	NCAFS	47,97 ± 8,70	43,73 ± 5,96	6.432	0.013
Subscales	Sensitivity	13,18 ± 2,58	12,83 ± 2,02	0.462	0.499
	Response to distress	9,64 ± 1,44	9,90 ± 1,23	0.736	0.394
	Socio emotional growth fostering	10,79 ± 2,66	9,40 ± 2,32	6.190	0.015
	Cognitive fostering	4,26 ± 1,68	3,30 ± 1,20	8.387	0.005
	Child's clarity of cues	6,92± 2,26	5,65 ± 1,67	8.110	0.006
	Child responsiveness	3,13± 1,52	2,08 ± 0,69	15.746	0.001

STUDY 2
(Twins)

TWINS

22 preterm twins newborns and their mothers divided into target group (9) and control group (13)

Stress at birth (Twins)

		KMC N= 9 Mean & SD	TC N=13 Mean & SD	F	Sig. .05
Total	Parent Stress Index	136,00 ± 15,775	136,31 ± 16,250	0.002	0.966
Subscales	Parental Distress	47,25 ± 5,625	48,00 ± 4,203	0.122	0.731
	Parent Child Dysfunctional Interaction	47,00 ± 7,270	47,15 ± 7,221	0.002	0.963
	Difficult Child	41,75 ± 7,166	41,15 ± 5,800	0.044	0.836
	Defensive Responding	28,00 ± 3,817	28,62 ± 2,103	0.230	0.637

Stress at discharge (Twins)

		KMC N= 9 Mean & SD	TC N=13 Mean & SD	F	Sig. .05
Total	Parent Stress Index	148,78 ± 13,737	135,54 ± 19,355	3.105	0.090
Subscales	Parental Distress	52,00 ± 5,339	47,15 ± 5,771	3.980	0.060
	Parent Child Dysfunctional Interaction	51,56 ± 4,531	44,46 ± 9,342	4.418	0.050
	Difficult Child	45,44 ± 7,073	43,31 ± 5,978	0.586	0.450
	Defensive Responding	30,67 ± 3,937	28,00 ± 3,317	2.955	0.100

Stress at discharge

General sample

		KMC N= 40	TC N=42	F	Sig.
		Mean e DS	Mean e DS		.05
Total	Parent Stress Index	143,60 ± 13,619	135,79 ± 16,153	5,582	0,020
Subscales	Parental Distress	46,68 ± 5,595	45,17 ± 7.115	6,120	0,010
	Parent Child Dysfunctional Interaction	50,43 ± 5,420	46,05 ± 7,050	9,865	0,002
	Difficult Child	44,55 ± 6,361	43,67 ± 6,599	0,380	0,540
	Defensive Responding	28,65 ± 3,215	26,83 ± 3,741	5,537	0,020

Twins

		KMC N= 9	TC N=13	F	Sig.
		Mean e DS	Mean e DS		.05
Total	Parent Stress Index	148,78 ± 13,737	135,54 ± 19,355	3,105	0,090
Subscales	Parental Distress	52,00 ± 5,339	47,15 ± 5,771	3,980	0,060
	Parent Child Dysfunctional Interaction	51,56 ± 4,531	44,46 ± 9,342	4,418	0,050
	Difficult Child	45,44 ± 7,073	43,31 ± 5,978	0,586	0,450
	Defensive Responding	30,67 ± 3,937	28,00 ± 3,317	2,955	0,100

Interaction at discharge (Twins)

		KMC N= 9 Mean & SD	TC N=13 Mean & SD	F	Sig. .05
Total	NCAFS	48,56 ± 8,70	42,00 ± 5,53	4.088	0.050
Subscale	Sensitivity to baby's signals	12,78 ± 3,07	12,15 ± 1,14	0.454	0.508
	Response to distress	10,67 ± 0,500	10,08 ± 1,382	1.484	0.237
	Socio emotional growth fostering	10,44 ± 2,78	8,15 ± 1,864	5.371	0.031
	Cognitive fostering	4,78 ± 1,48	3,15 ± 1,21	7.958	0.011
	Child's clarity of cues	7,00 ± 1,87	5,77 ± 1,42	3.080	0.095
	Child responsiveness	3,33 ± 1,58	1,92 ± 0,494	9.228	0.006

General sample

		KMC N= 40	TC N=42	F	Sig.
		Mean e DS	Mean e DS		.05
Total	NCAFS	47,97 ± 8,70	43,73 ± 5,96	6.432	0.013
Subscales	Sensitivity	13,18 ± 2,58	12,83 ± 2,02	0.462	0.499
	Response to distress	9,64 ± 1,44	9,90 ± 1,23	0.736	0.394
	Socio emotional growth fostering	10,79 ± 2,66	9,40 ± 2,32	6.190	0.015
	Cognitive fostering	4,26 ± 1,68	3,30 ± 1,20	8.387	0.005
	Child's clarity of cues	6,92± 2,26	5,65 ± 1,67	8.110	0.006
	Child responsiveness	3,13± 1,52	2,08 ± 0,69	15.746	0.001

Twins

		KMC N= 9	TC N=13	F	Sig.
		Mean e DS	Mean e DS		.05
Total	NCAFS	48,56 ± 8,70	42,00 ± 5,53	4.088	0.050
Subscales	Sensitivity	12,78 ± 3,07	12,15 ± 1,14	0.454	0.508
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	Cognitive fostering	4,78 ± 1,48	3,15 ± 1,21	7.958	0.011
	Child's clarity of cues	7,00 ± 1,87	5,77 ± 1,42	3.080	0.095
	Child responsiveness	3,33 ± 1,58	1,92 ± 0,494	9.228	0.006

STUDY 3

Aims study 3

To verify **KMC long-term influence**:

1. on mothers' emotional state: **stress**

2. on mother-child **interaction**

3. On **family style**

4. On the baby's **cognitive development**

5. the **length of the effect at** 3-6-12 months

METHODOLOGY
(STUDY 3)

Participants

64 preterm babies and their mothers

30 dyads

KMC

Mother practices KMC

34 dyads

CT

mother is invited to visit her child and to take him/her in her arms if she so wishes

Inclusion criteria:

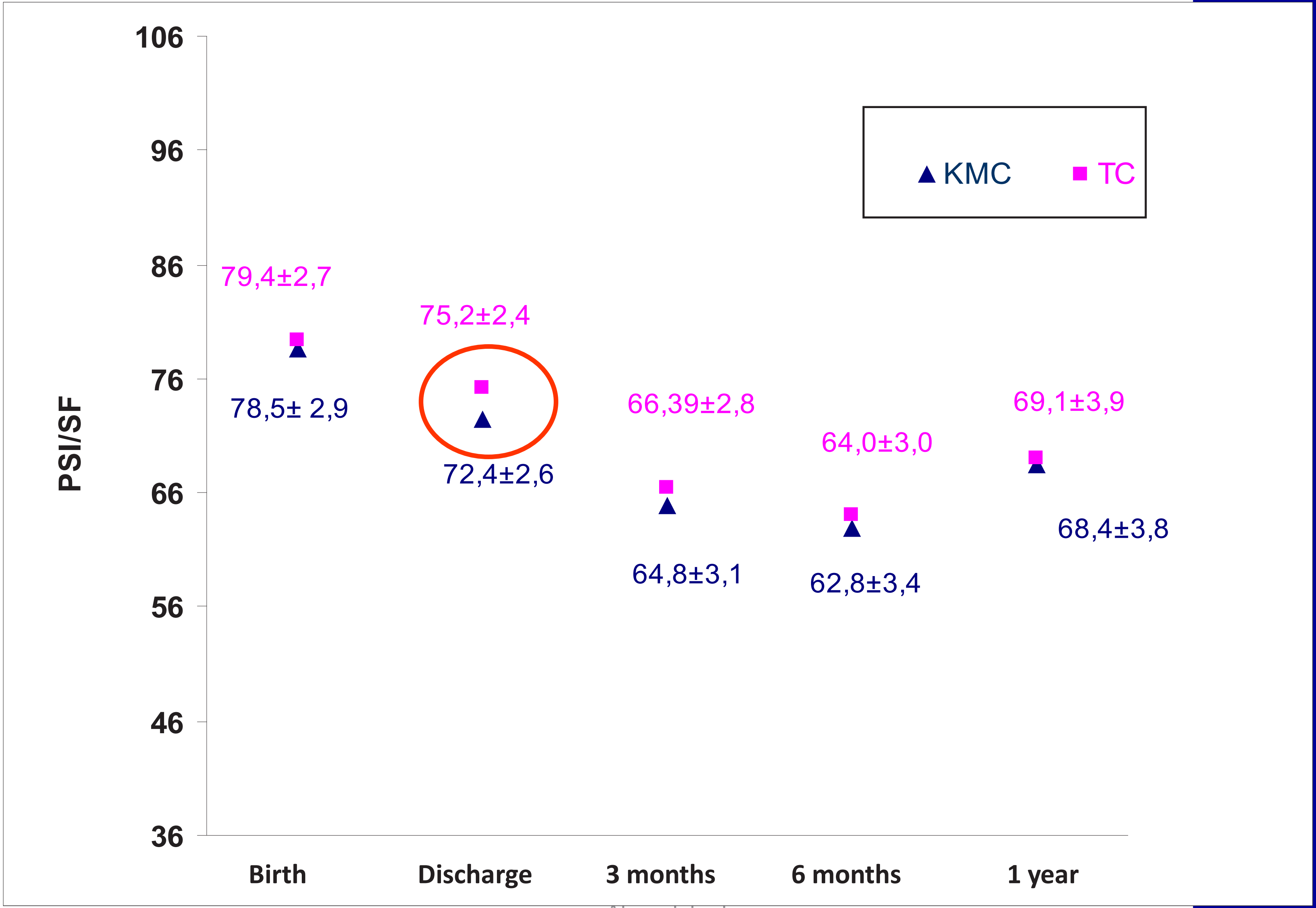
- Infant weight < 1800 g.
- Gestational age < 37 weeks
- Absence of any malformation in the baby
- Presence of both parents

Research Plan

DATA COLLECTION

BIRTH	GPP-I (maternal personality)	PSI/SF (maternal emotional stress)	
DISCHARGE	PSI/SF (maternal emotional stress)	Video tape-recording NCAFS (dyadic interaction)	
3 MONTHS	PSI/SF (maternal emotional stress)	Video tape-recording NCAFS (dyadic interaction)	
6 MONTHS	PSI/SF (maternal emotional stress)	Video tape-recording NCAFS (dyadic interaction)	
1 YEAR	PSI/SF (maternal emotional stress)	HOME (home environment)	BAYLEY (developmental functioning)

Mothers' stress differences between groups



Ahmedabad

Interaction at discharge

		KMC N= 30 Mean e DS	TC N=33 Mean e DS	F	Sig. .05
Total	NCAFS	44,4 ± 1,8	44,2 ± 1,7	0.19	0.96
Subscale	Sensitivity to baby's signals	13,2 ± 0,4	13,4 ± 0,4	0.42	0.83
	Capacity of alleviating the b's uneasinesss	9,1 ± 0,3	9,5 ± 0,3	1.49	0.21
	Socio emotional growth fostering	9,9 ± 0,6	10,1 ± 0,6	1.03	0.41
	Cognitive fostering	3,7 ± 0,3	3,4 ± 0,3	0.30	0.91
	Child's clarity of cues	5,7 ± 0,5	5,41 ± 0,4	0.88	0.50
	Child responsiveness	2,7 ± 0,3	2,37 ± 0,3	1.34	0.26

Ancova with two IV (type of care), five dependent variables (PSI/SF scores) and four covariates (infant gender, mother's age, mother's sociability, mother's residence)

Interaction at 3 months

		KMC N= 30 Mean e DS	TC N=33 Mean e DS	F	Sig. .05
Total	NCAFS	51,0 ± 1,9	44,7 ± 1,9	1.12	0.36
er	Sensitivity	13,6 ± 0,5	12,2 ± 0,4	1.21	0.32
	Response to baby's distress	10,1 ± 0,2	9,2 ± 0,2	1.42	0.23
	Socio emotional growth fostering	11,1 ± 0,5	8,8 ± 0,5	1.89	0.11
	Cognitive fostering	4,4 ± 0,4	3,5 ± 0,4	0.78	0.57
	Child's clarity of cues	7,7 ± 0,5	7,2 ± 0,5	0.46	0.80
	Child responsiveness	4,2 ± 0,4	3,4 ± 0,4	0.47	0.80

Ancova with two IV (type of care), five dependent variables (PSI/SF scores) and four covariates (infant gender, mother's age, mother's sociability, mother's residence)

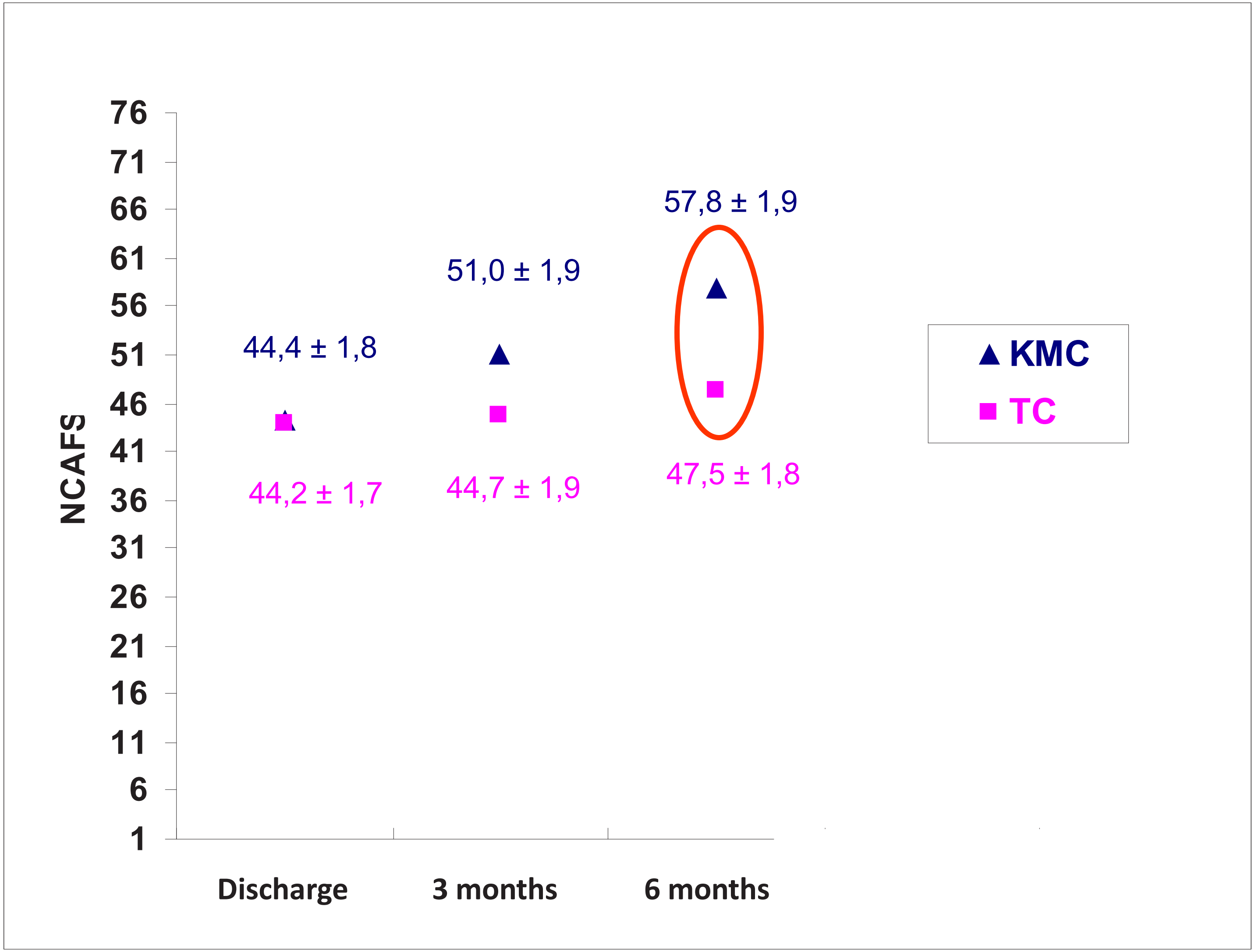
Interaction at 6 months

(STUDY 3)

		KMC N= 29 Mean e DS	TC N=34 Mean e DS	F	Sig. .05
Total	NCAFS	57,8 ± 1,9	47,5 ± 1,8	4.58	0.00
Subscale	Sensitivity to baby's signals	13,6 ± 0,3	11,9 ± 0,3	4.12	0.00
	Response to distress	10,9 ± 0,2	10,3 ± 0,2	2.29	0.06
	Baby's Socio emotional growth fostering	12,1 ± 0,5	9,6 ± 0,4	4.31	0.00
	Baby's cognitive development fostering	5,9 ± 0,5	4,7 ± 0,4	1.64	0.16
	Child's capacity to produce clear signals to the caregiver	9,7 ± 0,6	6,8 ± 0,5	2.38	0.05
	Child responsiveness	6,38 ± 0,5	3,5 ± 0,5	0.48	0.00

Ancova with two IV (type of care), five dependent variables (PSI/SF scores) and four covariates (infant gender, mother's age, mother's sociability, mother's residence)

Interaction mother-preterm baby: group analysis



Home environment at 1 year (HOME).

	1 year	KMC N = 27 Mean e DS	TC N = 26 Mean e DS	F	Sig. .05
Total	HOME	42,5 ± 0,6	41,9 ± 0,6	0.06	0.53
Subscale	Mother's emotional and verbal sensitivity	10,0 ± 0,3	10,2 ± 0,3	1.88	0.13
	Punishment: restriction and avoidance	7,2 ± 0,1	7,1 ± 0,1	0.10	0.98
	Physical environment organization	6,0 ± 0,1	5,5 ± 0,1	1.72	0.16
	Appropriate play material supplied	8,9 ± 0,2	8,3 ± 0,2	2.49	0.05
	Mother's involvement with the children	5,7 ± 0,1	5,6 ± 0,1	0.86	0.50
	Appropriate variation in daily stimulation	4,7 ± 0,1	4,6 ± 0,1	4.16	0.01

Ancova with two IV (type of care), five dependent variables (NCAFS scores) and four covariates (infant gender, mother's age, mother's sociability, mother's residence)

RESULTS

1. **Stress**: *KC mothers had a* lower level of *stress than* CT mothers *at discharge.*

2. Interaction: *at six months of corrected age* (babies) the *KC* dyads showed better interactivity *than* CT dyads:

- *higher level of sensitivity to baby's signals*
- *behaviour more conducive to favouring the social growth* -
- *higher capacity to produce clear signals for the caregiver*
- *higher capacity to provide appropriate responses to the caregiver*

3. Home environment: *at 1 year corrected age KMC* parents provide the baby with more appropriate play material and *more varied stimuli during the day than* CT parents

4. **Cognitive development:** *at 1 year corrected age KC babies* have reached a higher index of cognitive development than CT babies.

Discordances in the INTERACTIVE PROFILE

(Tallandini, Scalembra 2006)

At discharge, the behaviour of KC parents is more conducive to social and cognitive growth and KC infants show a greater capacity for *making their needs understood and higher responsivity* than CT dyads

(STUDY 3)

At discharge, KC dyads show an interactive profile similar to CT dyads

Study 1 groups are statistically different from study 3 group * (p>.05) for:

- number of children per mother (more children)
- type of delivery (caesarian) (more caesarian deliveries)
- mother's age (older mothers)
-

	Study 1	Study 3	
- KMC days	(24,4 ± 11,0)	(13,4 ± 7,1)	*F=18.12;Sig.= 0.00*
- KMC minutes	(2933,4 ± 1237,3)	(1834,2 ± 813)	*F=14.14;Sig.= 0.00*
- KMC per day	(123,7 ± 18)	(156,5 ± 43)	*F=10.01;Sig.= 0.00*

*Anova e Chi^2

Is there a dose effect?

Group 1	→	KC = 630-1407 minutes
Group 2	→	KC = 1408-2067 minutes
Group 3	→	KC = 2068-3745 minutes

HOMOGENEITY

The three groups are statistically similar ($p > .05$) for:

Infants

Gestational age, gender; birth weight; Apgar 1 min.; Apgar 5 min.; neonatal risk index (CRIB); type of delivery; number of twins; age in days when the infant starts KC; infant's weight when h/s starts and terminates KC; hospital stay duration; type of feeding.

Mothers

Mothers' age; mothers' education; mothers' work; children's number; medical checks; mothers' residence during baby's hospitalization; 9 out of 10 personality characteristics (GPPI).

Fathers

Fathers' age; fathers' education; fathers' work.

*Anova e Chi^2

Does the duration of KMC application influence the mothers' emotional *stress* at discharge?

	KC 630-1407 min N=10 Media e DS	KC 1408-2067 min N=11 Media e DS	KC 2200-3800 min N=9 Media e DS	F	Sig. .05
Parent Stress Index	78,4 ± 11,6	71,5 ± 11,0	68,9 ± 14,3	1,55	0,23
Parental Distress	26,3 ± 2,9	26,2 ± 7,5	21,1 ± 5,8	2,43	0,11
Parent Child Dysfunctional Interaction	23,6 ± 6,6	20,0 ± 4,7	20,0 ± 5,3	1,39	0,26
Difficult Child	28,5 ± 6,4	25,4 ± 5,1	27,8 ± 7,7	0,70	0,51
Defensive Responses	15,5 ± 1,6	14,4 ± 3,1	12,7 ± 3,9	2,18	0,13

Anova with three IV (KMC length) and 5 DV (PSI/SF subscales).

Does the duration of KMC application influence the mothers' emotional *stress* at 3 months ?

	KC 630-1407 min N=10 Media e DS	KC 1408-2067 min N=11 Media e DS	KC 2200-3800 min N=9 Media e DS	F	Sig. .05
Parent Stress Index	73,8 ± 10,3	63,6 ± 10,5	57,4 ± 14,7	4,66	0,02
Parental Distress	27,5 ± 6,1	23,1 ± 5,3	19,3 ± 5,7	4,84	0,02
Parent Child Dysfunctional Interaction	22,4 ± 3,6	17,7± 4,3	17,0 ± 4,5	4,90	0,01
Difficult Child	23,9 ± 6,0	22,8 ± 5,0	21,1 ± 5,6	0,61	0,55
Defensive Responses	15,7 ± 4,2	13,5 ± 3,3	11,0 ± 3,3	3,90	0,03

Anova with three IV (KMC length) and 5 DV (PSI/SF subscales).

Does the duration of KMC application influence the mothers' emotional *stress* at 6 months ?

	KC 630-1407 min N=10 Media e DS	KC 1408-2067 min N=11 Media e DS	KC 2200-3800 min N=9 Media e DS	F	Sig. .05
Parent Stress Index	69,2 ± 9,2	54,3 ± 10,9	65,7 ± 21,6	2,56	0,09
Parental Distress	23,9 ± 3,9	19,7 ± 6,8	23,4 ± 9,9	0,96	0,39
Parent Child Dysfunctional Interaction	22,4 ± 4,2	17,1 ± 3,1	18,9 ± 5,5	3,69	0,04
Difficult Child	22,9 ± 3,7	17,6 ± 3,5	20,3 ± 4,8	3,34	0,05
Defensive Responses	13,8 ± 3,3	11,2 ± 5,0	13,8 ± 6,6	0,77	0,47

Anova with three IV (KMC length) and 5 DV (PSI/SF subscales).

Does the duration of KMC application influence the dyadic interaction at discharge?

	KC 630-1407 min N=10 Media e DS	KC 1408-2067 min N=11 Media e Ds	KC 2068-3745 min N=9 Media e DS	F	Sig. .05
Nursing Child Assessment Feeding Scale	39,6 ± 6,8	44,9 ± 7,9	50,3 ± 6,7	5,25	0,01
Sensitivity to baby's signals	12,7 ± 2,2	13,1 ± 1,4	13,2 ± 2,0	0,95	0,39
Capacity of alleviating the baby's uneasiness	8,5 ± 1,3	9,8 ± 1,1	8,9 ± 1,5	2,77	0,80
Socio emotional growth fostering	8,9 ± 2,6	8,9 ± 2,9	12,2 ± 1,4	5,73	0,01
Baby's cognitive development fostering	2,9 ± 1,4	3,9 ± 1,5	4,7 ± 1,3	3,63	0,04
Baby's capacity to produce clear signals to the caregiver	4,5 ± 1,6	6,3 ± 2,7	7,0 ± 1,5	3,84	0,03
Baby's capacity of answering the caregiver	2,1 ± 0,3	2,9 ± 1,6	3,7 ± 2,3	2,32	0,12

Anova with three IV (length of KMC) and seven DV (NCAFS scores).

Does the duration of KMC application influence the mothers' emotional *stress* at 1 year?

	KC 630-1407 min N=10 Media e DS	KC 1408-2067 min N=11 Media e DS	KC 2200-3800 min N=9 Media e DS	F	Sig. .05
Parent Stress Index	72,6 ± 12,8	66,1 ± 18,8	65,4 ± 21,1	0,44	0,65
Parental Distress	27,1 ± 7,1	23,1 ± 6,9	25,1 ± 9,7	0,56	0,58
Parent Child Dysfunctional Interaction	23,0 ± 10,4	19,1 ± 4,6	18,1 ± 5,3	1,15	0,33
Difficult Child	25,0 ± 4,5	22,7 ± 6,8	20,4 ± 8,2	1,04	0,37
Defensive Responses	14,6 ± 2,3	12,6 ± 4,1	13,7 ± 4,3	0,50	0,61

Anova with three IV (KMC length) and 5 DV (PSI/SF subscales).

Does the duration of KMC application influence the dyadic interaction at 3 months?

	KC 630-1407 min N=10 Media e DS	KC 1408-2067 min N=11 Media e Ds	KC 2068-3745 min N=9 Media e DS	F	Sig. .05
Nursing Child Assessment Feeding Scale	48,6 ± 7,4	49,2 ± 11,1	53,4 ± 8,0	0,79	0,46
Sensitivity to baby's signals	13,3 ± 2,5	13,2 ± 2,3	14,0 ± 1,4	0,40	0,67
Capacity of alleviating the baby's uneasiness	9,7 ± 1,1	9,7 ± 1,1	10,0 ± 0,5	0,29	0,75
Socio-emotional growth fostering	10,9 ± 2,2	9,7 ± 2,7	11,8 ± 1,8	1,98	0,16
Baby's cognitive development fostering	4,6 ± 1,8	3,9 ± 2,0	4,4 ± 1,9	0,38	0,68
Baby's capacity to produce clear signals to the caregiver	6,8 ± 1,4	8,1 ± 3,2	8,7 ± 2,4	1,43	0,26
Baby's capacity of answering the caregiver	3,3 ± 1,8	4,5 ± 1,9	4,6 ± 2,3	1,29	0,29

Anova with three IV (length of KMC) and seven DV (NCAFS scores).

Does the duration of KMC application influence the dyadic interaction at 6 months?

	KC 630-1407 min N=10 Media e DS	KC 1408-2067 min N=10 Media e Ds	KC 2068-3745 min N=9 Media e DS	F	Sig. .05
Nursing Child Assessment Feeding Scale	56,9 ± 7,4	62,3 ± 9,4	52,8 ± 10,2	2,68	0,09
Sensitivity to baby's signals	12,9 ± 1,7	14,6 ± 1,6	13,2 ± 1,9	2,74	0,08
Capacity of alleviating the baby's uneasiness	10,8 ± 0,6	10,9 ± 0,3	11,0 ± 0,0	0,55	0,58
Socio-emotional growth fostering	12,1 ± 1,6	13,2 ± 1,9	10,7 ± 1,9	4,58	0,02
Baby's cognitive development fostering	6,4 ± 2,0	6,5 ± 2,3	4,9 ± 2,9	1,28	0,29
Baby's capacity to produce clear signals to the caregiver	9,2 ± 2,3	10,3 ± 2,9	8,3 ± 2,2	1,43	0,26
Baby's capacity of answering the caregiver	6,5 ± 2,8	6,8 ± 2,3	4,7 ± 2,4	1,95	0,16

Anova with three IV (lenght of KMC) and seven DV (NCAFS scores).

RESULTS "dose effect"

Stress: - at *3 months corrected age* in mothers who practiced more hours of *KMC* showed *less total stress*

- at *6 months* ***corrected age***, the group with *intermediate to high KMC* presented *less stress generated by the baby's characteristics and by difficulties of h/h interaction*

Interaction: - at *discharge* mothers who practiced more hours of *KMC* had a better general interactive style

- at *6 months corrected age*, the behaviour of parents who practised an intermediate quantity of KMC was more conducive to socio-emotional growth.

In general, more time dedicated to KMC has a positive *influence* on the mothers' stress levels and mother-baby dyadic interaction

- **Johnson M (2009) social brain**

+

- **Environment influences**

=

RESULTS

	KMC
Stress at discharge	lower than CT mothers
Dyad Interaction at 6 months (corrected age)	better interactivity greater sensitivity to baby's signals behaviour more conducive to social growth higher capacity to give appropriate reponses to caregiver
Family interaction with baby (1 year corrected age)	more appropriate play material more variety in stimulation
Cognitive development	Higher than CT babies

Conclusion

1. KMC is a very useful procedure as it helps to overcome mothers' psychological difficulties linked to preterm delivery.
2. KMC is very useful for the baby fostering h/h emotionl, social, and cognitive growth in the indicated areas.
3. KMC can have a positive influence on the family environment.
4. In general, more time dedicated to KMC has a positive *influence* on the mothers' stress levels and mother-baby dyadic interaction

- ***C. Scalembra***
- ***P. Corbatto***
- ***L. Genesoni***
- ***A. Huertas-Ceballos***
- ***R. Leigh Curran***
- ***V. Morsan***
- ***L. Tellini***

PRE-REQUISITES

STAFFING

- KC does not require any more staff than conventional care.
- Existing staff (doctors and nurses) should know when and how to initiate the KC method.

CAREGIVERS

- Adopting KC should be the result of an **informed decision** and should not be perceived as an obligation.
- The mother should recover before initiating KC if she has suffered complications during pregnancy or delivery or is otherwise ill.

- **BABY**
- Babies with severe illness or requiring special treatment may wait until recovery before KC begins. Babies are treated according to UCLH's clinical guidelines.
- KC sessions can begin when baby still requires medical treatment.
- However, **baby's condition must be stable**.
- The ability to feed (to suck and swallow) and breathe spontaneously are not an essential requirement (KC can begin during tube-feeding and while the baby is still in CPAP).

School of Mental Health, 27
Frognal, Hampstead, London, NW3 6AR, 12 June 2010

IMPLEMENTATION

- When exactly KMC can begin for premature babies **must be judged individually**, and full account should be taken of the condition and status of each baby and his/her caregivers.
- In general the following can be expected:

  -1800g≤ Soon after birth.

  -1200g and 1799g ≤A week

  -1200g≥Many weeks

School of Mental Health, 27
Frognal, Hampstead, London, NW3 6AR, 12 June 2010

IMPLEMENTATION

- When exactly KMC can begin for premature babies **must be judged individually**
- **Mother and child need to be ready**

KANGAROO POSITIONING

- **Between the mother's breasts in an upright position [chest to chest].**
- **Secure him/her with the binder**. The head, turned to one side, is in a **slightly extended position.**
- **Hips should be flexed and extended in a "frog" position; the arms should also be flexed.**
- **Tie the cloth firmly?? It depends from the type of pouch**. The baby's abdomen should not be constricted and should be somewhere at the **level of the mother's epigastrium.**

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DURATION AND MONITORING

- **Length**
- Skin-to-skin contact-gradually.
- Sessions that last less than 60 minutes should be avoided.
- **Duration**
- When the mother and baby are comfortable, skin-to-skin contact continues for as long as they like.
- It tends to be used until the baby reaches term or 2500g. This is when it is safe to advise the mother to wean the baby gradually from KC.
- **Monitoring the baby’s condition**
- Temperature
- Observing breathing and well-being
- Record keeping

KANGAROO POSITIONING

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Barriers reported by the medical and nursing staff in the implementation of KMC in high tech environment

- Wrongly considered a sub-standard care
- How to assess the infant readiness for KMC, such as infant safety concerns and physiological stability
- KC can be considered as extra work for the nursing staff in busy high tech environment (nurses ratio for each infant)
- Cultural issues can arise in culture where skin-to-skin contact between the providers and the baby is considered inappropriate
- Inadequate level of privacy during KC can be upsetting for certain mother
- Presence of cultural barriers to paternal participation

Implementation of KMC in NICU - UK

- **1. Preliminary steps:** Agreement of all medical and nursing staff on KMC implementation

  Provision of KMC written policies and guidelines for medical and nursing staff (see WHO guidelines)

  Creation of an informative booklet for parents

- 2. **Teaching staff:** Presence of a KMC Trained Nurse, in charge of the KMC implementation

  Regular teaching sessions to train the Nursing Staff

  Seminars about KMC on regular cycle offered to all components of the medical staff

Implementation of KMC in tertiary NICU - UK

- 4. To **KMC materials??:**Binder to secure the baby
  Mirror to see the baby's face
  Diary to register the KMC sessions
  and the carer observations

- 3.**Teaching parents:** **To** inform all parents in the Unit of the KMC existence
  To teach parents how to position, held and transfer the infant in and out the incubator

- 5. To provide **Continuous? education:**Regular team meetings to rectify and improve the implementation strategies

Difficulties experienced in the implementation of a KMC research project in the UK

- No Randomised Controlled Trial due to ethical issues

- Enlargement to a multi-site study which includes a network of hospitals where the infants are transferred in relation to their medical needs

- Recruitment of the Control group before implementing KMC intervention

  however:

  KMC was spreading fast within the NICU not due to hospital policies but thanks to certain nurses and doctors personal inclination towards KMC

Psychological effects of KMC

KMC mothers:

- present lower maternal stress (Tallandini & Scalembra, 2006)
- show fewer symptoms of depression (Feldman et al., 2002)
- perceive their infant as less abnormal (Feldman et al., 2002)
- have a better sense of parenting role (Affonso et al.,1993)
- feel more confident and competent in meeting their baby's needs (Tessier et al., 1998)

these results **have not been replicated in a UK setting**

(Miles et al., 2005; Whitelaw et al., 1988)

Aims of Research Project

Investigation of the effects of Kangaroo Mother Care (KMC) in a **British** context on:

- maternal psychological well-being
- mother-preterm infant relationship
- couple relationship

Conflicting results:

Italy & Israel

(Tallandini & Scalembra, 2006; Feldman et al., 2002;2003)

- KMC intervention for minimum 60 min per day

Positive effect of KMC

UK

(Whitelaw et al., 1988; Miles et al., 2005)

- KMC intervention for an average of 30 min (Whitelaw, 1998) or 20 min (Miles et al., 2005) per day

Neither benefit nor adverse consequences of KMC

Hypotheses 1/2

⇨ Maternal Psychological well-being

- lower **parental stress** (Tallandini & Scalembra, 2006)
- fewer symptoms of **depression** (Feldman et al., 2002)
- lower **anxiety** levels (Affonso, 1998)

Hypotheses 2/2

⇨ Mother-preterm infant relationship

- better **perception** of their infant (Feldman et al., 2002)
- better **attachment** to their infant

⇨ Couple relationship

- more **marital satisfaction**
- greater **parenting alliance**

Participants

64 preterm infants and their mothers:

KMC Group - 43 mother-preterm infant dyads
Control Group - 21 mother-preterm infant dyads

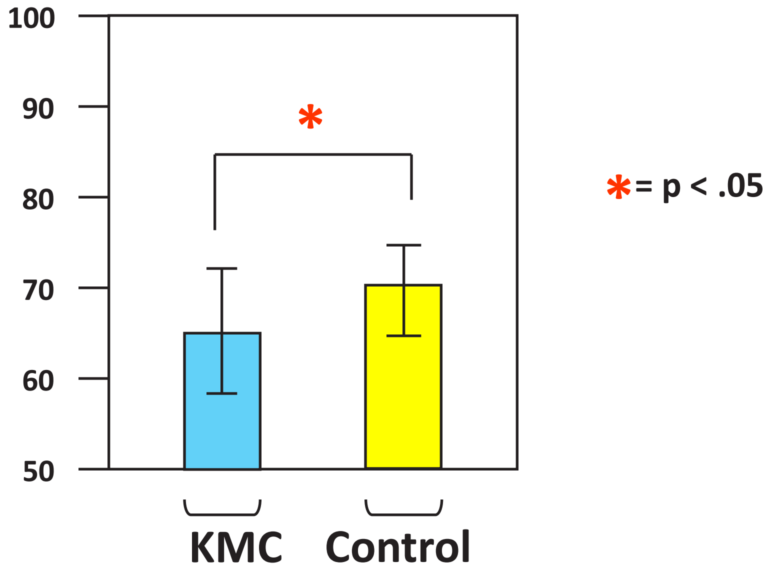
Eligibility criteria:

- less than 2000 g. and 37 weeks of GA at birth
- absence of congenital malformations
- absence of history of psychopathology and social issues in the family

Results 1/3

Study 1: Maternal Psychological well-being

➤ Parental Stress

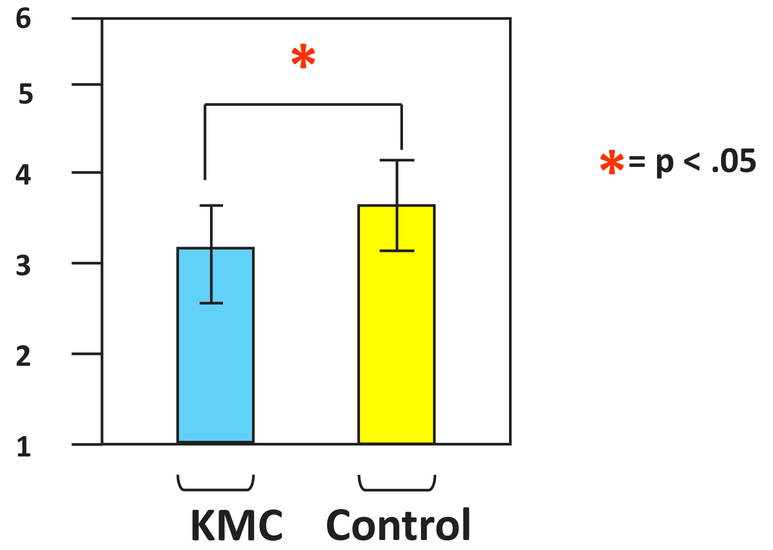


Mothers' PSI-SF total scores at discharge

Results 2/3

Study 1: Social Support

Social support

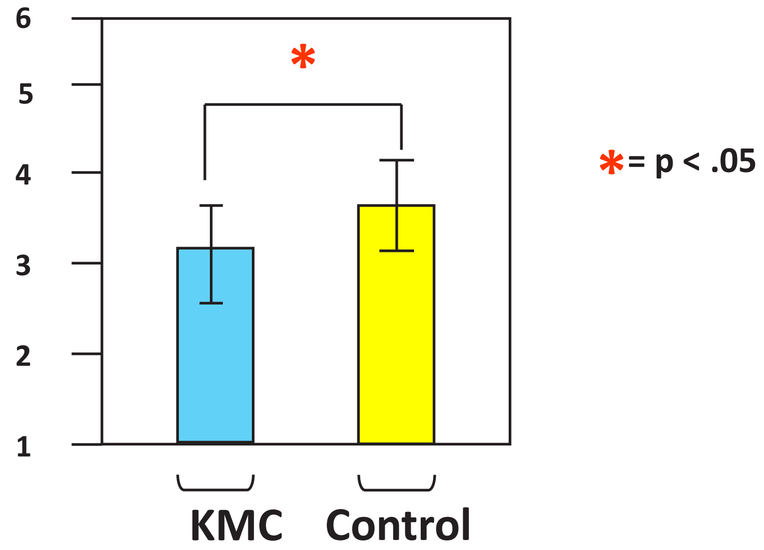


Mothers' FSS total scores after discharge

Results 2/3

Study 1: Social Support

Social support



Mothers' FSS total scores after discharge

Study 2:

intervention KMC

KMC Intervention **Group :** N = 24

- at least 60 min per day
- at least 14 consecutive days

Mean = 2,431.52 min; range 880-5,625

Limited KMC Group: N = 21

- at least 60 min per day
- less than 14 consecutive days

Mean = 487.38 min; range 100-800

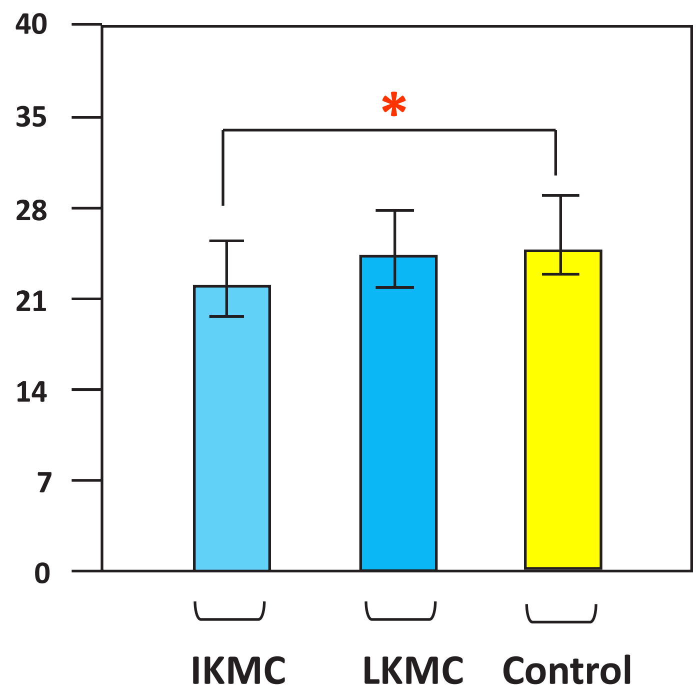
Control Group: N = 21

Statistical Analyses: ANCOVAS & MANCOVAS with CRIB II as covariate and Singletons/Twins added as a between-subjects factor

Results 2/3

Study 2: Maternal Psychological well-being

- Difficult Child
  PSI-SF Sub-Scale



* = p < .05

IKMC=Intervention KMC

LKMC=Limited KMC

Mothers' Difficult Child scores after discharge

Study 3:

KMC "dose" effect

Low Dose KMC Group: N = 12

- under the 25th percentile

  (range: 100 – 540 min.)

High KMC Group: N = 10

- over the 75th percentile

  (range: 2120 – 5625 min.)

Statistical Analyses: ANCOVAS & MANCOVAS with CRIB II as covariate

Results 1/2

Study 3: Mother-infant relationship

- Perception of the preterm infant

Mothers' NPI-II scores after discharge

Conclusions 1/2

Replication of earlier findings

(Tallandini & Scalembra, 2006; Feldman et al., 2002)

- **Positive** effects of KMC on:
  - ⇨ Parental Stress
  - ⇨ Maternal perception of the infant as a less "difficult child"

Conclusions 2/2

Novel Findings:

- Need of a minimum amount (1hour) of KMC
- Benefit of regular and scheduled intervention (14 days)
- Dose-effect of KMC (unlike previous studies, e.g. Tallandini & Scalembra, 2006; Miles et al., 2005)

⇨ **but only** on the mothers' perception of their infants

In attachment theory, several hypotheses about the association between attachment and cognitive development have been generated. In a series of meta-analyses on 32 studies, we tested whether the quality of attachment is related to intelligence (DQ or IQ) and to language competence. Attachment showed a weak association with DQ and IQ measures (combined r = .09; N = 1026). The combined effect size for the relation between attachment and language competence was r = .28 (N = 303). We conclude, first, that differences in intelligence do not play a major role in shaping attachment relationships. Differences in quality of attachment are not confounded in any significant way with differences in intelligence. Second, secure children appeared to be more competent in the language domain than insecure children. Language development appears to be stimulated in the context of a secure attachment relationship because secure parents may be better 'teachers' and secure children may be better motivated 'students'.

Cognitive and Behavioral Outcomes of School-Aged Children Who Were Born Preterm: A Meta-analysis
FREE

Adnan T. Bhutta, MBBS; Mario A. Cleves, PhD; Patrick H. Casey, MD; Mary M. Cradock, PhD; K. J. S. Anand, MBBS, DPhil

JAMA. 2002;288(6):728-737. doi:10.1001/jama.288.6.728.

Text

ABSTRACT

Context The cognitive and behavioral outcomes of school-aged children who were born preterm have been reported extensively.

Objective To estimate the effect of preterm birth on cognition and behavior in school-aged children.

Data Sources MEDLINE search (1980 to November 2001) for English-language articles, supplemented by a manual search of personal files maintained by 2 of the authors.

Study Selection We included case-control studies reporting cognitive and/or behavioral data of children who were born preterm and who were evaluated after their fifth birthday if the attrition rate was less than 30%. From the 227 reviewed studies, cognitive data from 15 studies and behavioral data from 16 studies were selected.

Egger weighted-linear regression method.

Data Synthesis Among 1556 cases and 1720 controls, controls had significantly higher cognitive scores compared with children who were born preterm (weighted mean difference, 10.9; 95% confidence interval [CI], 9.2-12.5). The mean cognitive scores of preterm-born cases and term-born controls were directly proportional to their birth weight (R^2 = 0.51; P<.001) and gestational age (R^2 = 0.49; P<.001). Age at evaluation had no significant correlation with mean difference in cognitive scores (R^2 = 0.12; P = .20). Preterm-born children showed increases in externalizing and internalizing behaviors in 81% of studies and had more than twice the RR for developing ADHD (pooled RR, 2.64; 95% CI, 1.85-3.78). No differences were noted in cognition and behaviors based on the quality of the study.

Conclusions Children who were born preterm are at risk for reduced cognitive test scores and their immaturity at birth is directly proportional to the mean cognitive scores at school age. Preterm-born children also show an increased incidence of ADHD and other behaviors.

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Language Abilities in Children Who Were Very Preterm and/or Very Low Birth Weight: A Meta-Analysis

Conclusions

Language ability is reduced in VPT/VLBW children. When considering only school-aged children, this reduction is still present, suggesting that their difficulty appears to be ongoing. Rigorous studies examining a range of language subdomains are needed to fully understand the specific nature of language difficulties in this population.