The Infant Behavioral Assessment and Intervention Program to support preterm infants after hospital discharge: a pilot study

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In this pilot study we investigated the feasibility of The Infant Behavioral Assessment and Intervention Program (IBAIP) in a group of preterm infants. At the age of 6 months, the neurobehavioural organization and self-regulatory competence of an intervention group was compared with a control group who had received the standard follow-up care. The intervention group consisted of 13 males and seven females (mean gestational age [GA] 29.2 weeks, SD 1.3wks; mean birthweight 1232g, SD 320g). The control group consisted of 11 males and nine females (mean GA 29wks, SD 1.6wks; mean birthweight 1198g, SD 397g). Inclusion criteria were: a GA of 32 weeks and family residence in the district of Amsterdam. Exclusion criteria were: severe congenital abnormalities, intraventricular haemorrhage grade III or IV, periventricular leukomalacia grade III or IV, and infants whose mothers had a history of illicit drug use. The intervention infants received 6 to 8 IBAIP interventions at home, from discharge until 6 months of age. The Neonatal Behavioral Assessment Scale was administered at term; the Infant Behavioral Assessment (IBA) at term, 3, and 6 months of age; and the Bayley Scales of Infant Development–II at 3 and 6 months (corrected age). At 6 months, intervention infants showed less stress and more approach behaviours on the IBA compared with control infants. These promising results warrant further evaluation in a randomized controlled trial.

See end of paper for list of abbreviations.

Many low-risk preterm infants and their parents encounter interaction problems in early infancy. Characteristics of preterm infants make mutually satisfying parenting difficult to achieve and contribute to levels of parental stress (Field 1979, Minde 1983, Barnard and Kelly 1990, Singer 1999). Factors may include: a lack of physiological and state control (Fox 1983, Barr 1996), motor regulation problems (de Groot 1997, Mouradian 2000), difficulties in sensory information processing (Rose and Wallace 1985), attention or affective problems (Field 1979, Mouradian 2000), and the infant's medical condition (Singer 1999). Although these characteristics seem to be adaptive problems which disappear with time, they may be, alone or in combination, early markers of the important long-term effects of preterm birth (Perlman 2001).

Neuro and developmental deficits that become apparent in a preterm infant's later childhood adversely affect their social relations and school performance (Hille et al. 1994, Wolke and Meyer 1999, Saigal 2000, Hille et al. 2001). As the infant's developing neurobehavioural competence and later developmental outcomes may be 'buffered' by early caregiving conditions (Bakeman 1980, Shore 1997, Bronson 2000, Shonkhoff and Phillips 2001) the Infant Behavioral Assessment and Intervention Program (IBAIP; Hedlund 1998) was introduced to provide these infants and their parents with post-discharge support. The IBAIP assists parents and interventionists in adjusting their own interaction style to match the neurobehavioural needs of the infant more closely as they mature over time. The Synactive Model of Newborn Behavioural Organization and Development and the Newborn Individualized Developmental Care and Assessment Program (NIDCAP) served as the theoretical base upon which the IBAIP was developed (Als 1986, Als et al. 1986). The NIDCAP aims at reducing stress and supporting the infant's individual neurobehavioural organization throughout their stay in the neonatal intensive care unit (NICU), and enhances the parents' ability to support the neurobehavioural integrity of their baby. The few published studies on NIDCAP care describe shorter hospitalization, earlier oral feeding, decreased severity of medical problems, improved parent–infant interaction and developmental outcome in the short term (Als et al. 1986, Als 1994, Westrup 2000, Kleberg 2002). Indications of long-term positive effects on mother–child interaction and decreased behavioural problems have been reported in another recent Swedish study (Kleberg 2000). The methodological quality of these NIDCAP studies have, however, been criticized in peer reviews (Jacobs 2002, Symington and Pinelli 2002). These experts do agree that infants currently living within the hospital NICU environment may experience stress and discomfort caused by inappropriate environmental stimulation and caregiving that is not attuned to the infant's self-regulatory or co-regulatory needs. Suggestions for better designed NIDCAP-based intervention studies have been offered.

According to Als (1992), support and intervention should not end when the infant is discharged from the NICU, but must systematically link families and infants to sound models of community-based support that build on the care and intervention provided in the NICU. In addition, Singer (1999) recommends support services for mothers of preterm infants in the immediate postnatal period to be incorporated in follow-up programmes. We hypothesized that the IBAIP, serving as this neurobehavioural continuum, may prevent or restore mismatches in early interaction in the short term and may consequently protect the preterm infant from neurobehavioural and developmental deficits later in life. To date, no intervention studies using the IBAIP have been published with regards to either short- or long-term outcome; therefore, we designed two pilot studies in preparation for a larger, randomized effect study. In the first pilot study, we investigated the neurobehavioural profile of preterm infants with the Infant Behavioral Assessment (IBA; Hedlund and Tatarka 1988) and concluded that it was a valuable instrument in systematically observing and discriminating differences in self-regulation (Wolf et al. 2001, 2002). The question posed in the present pilot study was: Do preterm infants who received IBAIP intervention differ at the corrected age of 6 months in neurobehavioural outcome and self-regulatory competence from a control group of preterm infants that received standard post-discharge care?

Method

PARTICIPANTS

From January 2001 to July 2001, a group of 24 preterm infants admitted consecutively to the NICU of the Academic Medical Centre in Amsterdam, the Netherlands was recruited to form the intervention group. The intervention group was compared with a control group of 20 preterm infants who had been recruited consecutively from January 1999 to July 1999 from the NICU of the same hospital (Wolf et al. 2002). The setting was a traditional NICU in which NIDCAP formed no part of the care. Recruitment took place 1 to 2 weeks after birth. Inclusion criteria for both groups were: a gestational age of <32 weeks and family residence in the district of Amsterdam, the Netherlands. Exclusion criteria for both groups were: severe congenital abnormalities, intraventricular haemorrhage grade III or IV (Papile et al. 1983), periventricular leukomalacia grade III or IV (de Vries et al. 1992), and infants whose mothers had a documented history of illicit drug use. Gestational age was determined by maternal history and ultrasound examination in early pregnancy, and confirmed postnatally with the Dubowitz score (Dubowitz et al. 1998) if antepartum information was inconclusive. Written informed consent was obtained from the parents during admission of their children and the Medical Ethics Committee of the Academic Medical Centre in Amsterdam approved the study.

Both the intervention and the control group received medical and feeding consultations after discharge, which are given every 2 weeks as a standard procedure by the infant's own paediatrician. Both the intervention and the control group received three home visits, at term, and at 3 and 6 months of corrected age, in order to assess neurobehavioural functioning and developmental outcomes for the study. The Neonatal Behavioral Assessment Scale (NBAS; Brazelton and Nugent 1995) was administered at term age, the Infant Behavioral Assessment (IBA) at term, 3, and 6 months, and the Bayley Scales of Infant Development–II (BSID-II; Bayley 1993) at 3 and 6 months of age. All assessments were recorded on and scored from video recordings. In addition, the intervention infants received 6 to 8 home interventions depending on the needs of the parents. These were initiated in the first week after discharge and continued until the baby was 6 months of corrected age. Each home visit lasted approximately 1 hour. After each intervention at home the parents received a written report of the infant's neurobehavioural progress with recommendations to support their infant's developing self-regulatory competence.

PROCEDURE

Home visits

All interventions and measurements were administered at home, in the presence of the infants' mother and/or father, by two specially trained paediatric physical therapists (KK, MJW) who had achieved competence in the scoring of the NBAS and the IBA at greater than 90% interrater reliability. The interventionists communicated with the parents in Dutch or English. During one home visit to a Turkish family, a friend of the family acted as an interpreter during the intervention sessions.

The Infant Behavioral Assessment and Intervention Program

The IBAIP offers training to health professionals working with infants in the administration of the Infant Behavioral Assessment (IBA; Hedlund and Tatarka 1988) and the implementation of the Neurobehavioral Curriculum for Early Intervention (NCEI; Hedlund 1998). The IBA evaluates the neurobehavioural organization and self-regulatory competence of the infant through repetitive IBA observations of the infant within the context of their environment, thus interpreting the behavioural communication of the child. Based upon this behavioural interpretation, NCEI facilitation strategies are then offered to best support the infant's neurodevelopmental progression and self-regulatory competence. The facilitation strategies address environmental facilitation (e.g. visual and auditory input), handling and positioning (e.g. the infant's position in supine or prone), and cue-matched facilitation (e.g. hand to mouth, foot bracing, or foot clasp). The facilitation may range from low support (e.g. positional adjustments to facilitate a tucked midline position) to high support (e.g. the use of swaddling to maintain this position). The degree and intensity of NCEI facilitation provided to the infant is based upon the self-regulatory efforts that are being employed by the infant to accomplish their social-interaction or caregiving goal. It implies a circular checking and rechecking across systems as the interaction proceeds, and in practice, is a continuous, seamless loop as the adult constantly assesses the child's behaviour while making necessary co-regulatory adjustments. In this way, the intervention provides ample opportunities for the infant to approach the information without distress and to enhance the infant's autonomy. As functioning becomes increasingly stabilized and neurobehavioural organization matures, co-regulatory supports offered by the adult may be gradually reduced. The IBAIP embeds the programme in the interactions of everyday family life and applies non-intrusive, positive, and competence-guided intervention strategies which allow the build-up of trust and a working alliance of the interventionist with the parents.

The NCEI is not a developmental curriculum with specific objectives to encourage (e.g. the successful tracking of a red ball). It supports the self-regulatory competence of the infant during such an interaction. As the focus of the regulatory strategies is midline orientated (e.g. bringing hands together and hands to mouth, as in normal midline development) it enhances both regulation and postural fixation and exploring activities and may indirectly stimulate the infant's early developmental milestones.

Neonatal Behavioral Assessment Scale

The NBAS evaluates the infants' status in four dimensions of functioning: autonomic stability, motor organization, state organization, and attention/interaction capacities. The NBAS scoring system includes seven supplementary items. These supplementary items are used to assess the behavioural quality of high-risk neonates. Each of the behaviours is scored on a 9-point scale. The conceptually and empirically based seven-cluster scoring method, developed by Lester (1976), was used for data reduction. A higher cluster score indicates closer to optimal behaviour.

Infant Behavioral Assessment

The Infant Behavioral Assessment (IBA) may be used to observe infants from birth until 6 months of corrected age. It is a 2 minute observation of the infant's behavioural responses that is primarily intended for clinical use.

Drawing upon the conceptualization of the Synactive Model (Als 1986), Hedlund and Tatarka (1988) have expanded upon this theoretical construct. The IBA identifies four intra-organism subsystems. These include the autonomic, motor, state, and attention/interaction subsystems. One hundred and thirteen discrete behaviours are operationally defined: 26 autonomic/visceral cues, 44 motor responses, 9 state categories, and 34 attention/ interaction cues. The four subsystems are seen as 'avenues of communication'. The infant uses behaviours within each of the four subsystems to: (1) engage in the exploration and processing of cognitive and social–emotional information; (2) stabilize themselves during this process of engagement; or (3) defend themselves by momentarily breaking the intensity of the interaction; or (4) remove themselves from environmental or social stimuli by terminating the interaction.

Three categories of communicative behaviour have been identified. (1) Approach behaviours, which may be interpreted to indicate that the sensory input that is being received by the infant matches their readiness to process and to make sense of the information. The infant is saying, 'I am actively engaged and enjoying this interaction.'

(2) Self-Regulatory behaviours, which may be interpreted to be those strategies that the infant uses to maintain a balanced, relatively stable state across and among all four subsystems or to return to such a state of balance. The infant uses self-regulatory behaviours to: (a) Concentrate, process, and learn from the stimuli that are offered to them. For example, if the infant is presented with a toy in midline to visually explore, they may call upon a self-regulatory behaviour (e.g. hand to mouth, bracing, or holding on) to assist their concentration on and processing of the information (the toy) that is being presented them. (b) Cope, 'hold on', or contend with a presented stimulus or developmental task. Self-regulation, used as a coping strategy, will assist the infant to continue to maintain a balanced, relatively stable state across and among all four subsystems while simultaneously attending to a presented task. Drawing from the example above, the infant is now asked to visually track the toy as it is moved from side to side, across their horizontal visual field (a more challenging and demanding task). The infant may now simultaneously call upon several self-regulatory strategies within their behavioural repertoire (e.g. they may need to bring their hand to mouth to suck on, brace with their feet on a supporting surface, and hold on to their own clothing with their other hand) and/or seek additional co-regulatory support from the adult in an attempt to cope or contend with the increased difficulty of the task (e.g. a change in position, or assistance in maintaining hand to mouth). This should suggest to the interventionist that the task at hand is challenging for the infant, may be at the expense of their energy, and that any increased demands or input offered to them may cause upset or stress. (c) Console themselves, if pushed beyond their input threshold, in an attempt to regain a state of neurophysiological subsystem balance. Again, using the scenario provided above, the interventionists now speaks to the infant, encouraging them as they is tracking the object across their horizontal visual field. Although this audio input may be meant as a support to assist or encourage the infant to continue with the task, the interventionist's voice may be too much for the infant to process simultaneously and may, therefore, lead to the expression of stress behaviours. Infants may now use self-regulatory strategies (e.g. hand to mouth) as a means of consoling or comforting themselves, in attempt to calm themselves from an agitated state of fussing or crying.

(3) Stress behaviours indicate that the sensory input the child is receiving is too intense, too frequent, too long, or too complex. The infant is saying, 'I need some time out from this interaction' or 'I'm not ready for this level of information right now.'

These three communicative-behaviour categories reflect both the infant's response to sensory input and the neurobehavioural integrity of the four subsystems. This will then guide the parent or interventionist's interaction with the infant and assists them in providing the appropriate co-regulatory support. In general, the more competent the infant is in using self-regulation or co-regulatory support, the greater their ability to engage in interactions will be and the more likely one is to observe approach behaviours. Infants who are neurophysiologically disorganized often make weak or unsuccessful attempts at self-regulation, or tend to display stress behaviours in an attempt to terminate an interaction that may be infringing upon their neurophysiological integrity and self-regulatory competence.

In both the intervention and the control group, the IBA was administered according to the directions in the manual and using IBA scoring sheets. The IBA provides a 2-minute 'observation window' of the infant's behavioural repertoire during interaction. At term age, the observation window was created during the NBAS administration of the 'red ball', and at 3 months of age during the BSID-II administration of the item 'Glancing from Bell to Rattle', and at 6 months during the 'Exploration of the Bell'. For this study we quantified the data, and calculated frequency measures for each behavioural category (i.e. approach, self-regulatory, stress) within the subsystems (i.e. autonomic, motor, state, attention/interaction) by counting the occurrence of approach, self-regulatory, and stress behaviours. An overall sum score of approach, self-regulatory, and stress behaviours was calculated as the sum of the four subsystem frequency scores for each behavioural category.

Bayley Scales of Infant Development–II

All three BSID-II scales, the Mental, Psychomotor, and the Behavioural Rating Scale, were administered at 3 and 6 months of age. The MDI and the PDI have been standardized to a mean of 100 with a standard deviation (SD) of 15. Scores below 85 and below 70 have been classified as mildly delayed (–1SD) and delayed performance (–2SD) respectively. For the Behavioral Rating Scale two factor scores are measured at the age of 3 months: the attention/arousal factor and the motor quality factor. At age 6 months, three factor scores are measured: orientation/engagement, emotional regulation, and motor quality. The orientation/engagement factor can be interpreted as approach behaviour in tasks or social situations. Emotional regulation refers to the process and characteristics involved in coping with emotions. The motor quality factor assesses a variety of neuromotor functions, i.e. muscle tone, posture, fine and gross motor movements, and frenetic movements (Bayley 1993). A score ranking at or above the 26th centile is classified as normal. A score between the 11th and 25th centiles is questionable, and a score ranking at or below the 10th centile is classified as non-optimal, which indicates that the infant is demonstrating delayed or impaired behaviours in one or more areas. The factor scores fall into the same descriptions as the total score. As there was no standardization for Dutch children at the time of the studies, normative values from the USA were used.

STATISTICAL ANALYSIS

Data were analyzed using the SPSS program (version 10.0; SPSS, Chicago, IL, USA) Group differences on continuous measures were analyzed using the Mann–Whitney *U* test (two-sided). Differences on categorical measures (e.g. occupation and marital status of the parents and ethnicity) between the two groups were analyzed using the χ^2 test. A p value of 0.05 was used for all tests of significance. Differences in longitudinal development over time of the IBA sum scores for approach, self-regulation, and stress between the groups were analyzed with generalized estimating equations. To account for differences at baseline, longitudinal analysis of covariance (autoregression) was used, i.e. change between term age and 3 months corrected for differences at term age, and the change between 3 and 6 months corrected for the differences at 3 months (Twisk 2003). Generalized estimating equation analysis was performed with the STATA statistical package (StataCorp, College Station, Texas, USA).

Table I: Neonatal and sociodemographic characteristics in intervention (n=20) and control groups (n=20)

Demographics	*Intervention*	*Control*
Neonatal characteristics		
Gestation, mean (SD) wks	29.2 (1.3)	29 (1.6)
Birthweight, mean (SD) g	1232 (320)	1198 (397)
Small for GA (<10th centile), *n*	5	4
Sex, M/F	13/7	11/9
Ethnicity (White/Other), *n*	6/14	8/12
Parity, first born, *n*	10	11
Apgar score at 5min (median C25, C75)	9[a] (8, 10)	8 (6, 9)
Ventilation mean (SD), days	3.2 (6.9)	4.35 (5.9)
Intraventricular hemorrhage (grades I, II), *n*	4	2
Periventricular leukomalacia (grade I), *n*	1	3
Bronchopulmonary dysplasia, *n*	5	5
Retinopathy of prematurity (grades I, II), *n*	3	3
Sociodemographic characteristics		
Family status of two parents, *n*	17	18
Father unemployed, *n*	6[a]	1
Maternal age, mean (SD) y	29 (5.5)	33 (5.4)
Paternal education, *n*		
Not high school graduate	14	10
High school graduate	6	10
Maternal education, *n*		
Not high school graduate	13	12
High school graduate	7	8

[a]$p \leq 0.05$. GA, gestational age; C25, C75 are centiles.

Results

Twenty–four infants were eligible for the study during the period of inclusion. Parents of two infants declined to participate. Two infants died after recruitment, before the start of the intervention, leaving 20 infants (13 males, seven females) for intervention. The infants' parents were from a mixed variety of ethnic backgrounds and 70% belonged to ethnic minorities from Turkey, Africa, Asia, and the Caribbean. All infants completed the intervention. These intervention infants were compared with a control group, collected 2 years earlier, using the same inclusion and exclusion criteria. The intervention and control group did not differ in age at discharge or medical history except for Apgar score (Table I). No significant difference between the two groups was found in family status, composition of household, ethnicity, or maternal and paternal years of education, but there were more unemployed fathers in the intervention group. At term age, the infant's neurobehavioural competence did not differ on the NBAS and IBA, except for the motor system cluster of the NBAS, on which the intervention group performed significantly better (5.2 vs 4.1, not shown), and the autonomic cluster of the IBA, on which the intervention group showed more approach and less stress behaviour (Table II) when compared with the control group. As all but three intervention infants received one or two interventions before term age, this may have influenced the comparability of the two groups in the neonatal period.

NEUROBEHAVIOURAL OUTCOME

The findings of the IBA at term, 3, and 6 months are shown in Table II. At 3 months, the intervention group displayed more approach behaviours in the autonomic, motor, and attention/interaction subsystems. Moreover, the intervention group exhibited less stress behaviour in the motor subsystem. There was no significant difference in self-regulation, except in the state subsystem. At 6 months, the intervention group showed more approach behaviour in all but the state subsystem, less self-regulation in the state and attention-interaction subsystems, and less stress in all subsystems. The self-regulatory behaviours of the intervention group were successful as they resulted in more approach and less stress behaviours. The self-regulatory behaviours of the control group were less successful, demonstrated by their less frequent approach behaviours and more frequent use of stress behaviours (i.e. higher scores on stress behaviours). This indicates that infants in the intervention group were not only exploring their environment more, they also had more neurobehavioural stability and their interactions had a lower energy cost compared with the control group.

Differences in longitudinal development over time are demonstrated by the results of the generalized estimating equations analyses which indicated that, on average, the intervention group scored 2.4 points (SE 0.6) higher on the IBA approach sum score than the control group and scored 2.8 points (SE 0.6) lower on IBA stress sum score than the control group. No group difference was found in longitudinal development of the IBA self-regulatory sum score (see Table II). This means that despite the same direction of neurobehavioural development over time, indicating more approach and less stress in both groups, an increasing divergence between the two groups in neurobehavioural competence is demonstrated.

The findings of the Behavioral Rating Scale of the BSID-II are shown in Tables III and IV. At 3 months of age the intervention infants showed a higher Behavioral Rating Scale total score, with both better attention/arousal scores and motor quality factor scores. At 6 months of age the intervention infants also showed a higher Behavioral Rating Scale total score, with differences in motor quality factor score, the orientation, and the emotional/regulation score, compared with the control group.

DEVELOPMENTAL OUTCOME

Results of the two groups on the Mental Developmental Index (MDI) and Psychomotor Developmental Index (PDI) of the BSID-II at 3 and 6 months of age are shown in Tables III and IV. At the age of 6 months, the intervention infants scored much higher than the infants of the control group. These differences, in favour of the intervention infants, were already visible at 3 months of age. At this age, the mean MDI in the intervention group was 96, compared with 89 in the control group. At 6 months of age, the intervention group showed a mean MDI of 100, compared with 91 in the control group. Mean PDI of the intervention group at 6 months was 94, compared with 78 in the control group.

Discussion

This pilot study was designed to explore the feasibility of the IBAIP in a group of preterm infants and their parents in the first 6 months at home. In this study we found that the IBAIP did not have detrimental effects on the infants. Moreover, we were able to demonstrate clinically significant differences in neurobehavioural competence in favour of the intervention group at 6 months of corrected age. However, due to the design of the study, our results should be interpreted with caution: our study group was small and, although all assessments were recorded on video, the investigators were not blind to treatment modality because they had also performed the intervention.

If, indeed, our results demonstrate a beneficial effect of the IBAIP, we hypothesize that the more favourable neurobehavioural organization and self-regulatory competence of the intervention infants was caused by the mediating skills of parents. Parents appeared to provide the necessary co-regulatory support (i.e. handling and positioning, environmental, or cue-matched strategies) that enabled their infant to be engaged by their environment and the people within it. The enhanced neurobehavioural organization may have indirectly supported their early developmental milestones at the age of 6 months. In line with this hypothesis, Lundqvist (2001) described the infant's self-regulatory competence as an important contribution of the child in the interactive process, using an instrument based on the NBAS. She found a clear correlation between the level of self-regulation at term age and developmental outcome on the Griffiths test at 2 years of age in term infants. Functional maturation, like the level of self-regulation, has also been described in preterm infants to reflect structural maturity and integrity of brain areas, which enables developmental processing (Buehler et al. 1995, Huppi et al. 1996).

Looking at the different categories of behaviour (approach, self-regulation, and stress) on the IBA in our study, it appeared

Table II: Infant Behavioral Assessment (IBA): autonomic, motor, state, attention/interaction cluster scores, and sum scores in intervention (*n*=20) and control infants (*n*=20) at term, 3, and 6 months of corrected age

Assessment parameter	*Term*			*3 months*			*6 months*		
	Intervention Median (C25, C75)	*Control Median (C25, C75)*	*p*[a]	*Intervention Median (C25, C75)*	*Control Median (C25, C75)*	*p*[a]	*Intervention Median (C25, C75)*	*Control Median (C25, C75)*	*p*[a]
Autonomic cluster									
Approach	2 (2, 2)	1 (1, 2)	0.001	3 (3, 4)	2.5 (2, 3)	0.02	4 (3, 4)	3 (2, 3.5)	0.02
Self-regulation	1 (1, 2)	2 (1.2, 2)	*ns*	1 (0, 1)	1 (1, 2)	*ns*	0.5 (0, 1)	1 (0, 2)	*ns*
Stress	2 (2, 3)	3.5 (2.2, 4.7)	0.007	0 (0, 1)	1 (0, 1)	*ns*	0 (0, 0)	0 (0, 1)	0.04
Motor cluster									
Approach	5 (2, 5)	3.5 (2, 5)	*ns*	6 (5, 7)	4.5 (4, 6.7)	0.03	9.5 (8, 10)	7 (6, 8)	0.01
Self-regulation	5 (2, 6)	5.5 (4, 7)	*ns*	5 (4, 8)	5 (3, 7)	*ns*	7 (6.2, 8)	8 (7, 8)	*ns*
Stress	4 (2, 5)	5 (3.2, 7)	*ns*	2 (1, 3)	4 (2.2, 4)	0.02	1.5 (1, 2.7)	4 (2, 4.5)	0.001
State cluster									
Approach	1 (1, 1)	1 (0, 1)	*ns*	1 (1, 1)	1 (1, 1)	*ns*	1 (1, 1)	1 (1, 1)	*ns*
Self-regulation	1 (1, 2)	2 (1, 2)	*ns*	1 (0, 1)	0 (0, 1)	0.04	0 (0, 0)	1 (0, 1)	0.003
Stress	0 (0, 1)	0.5 (0, 1)	*ns*	0 (0, 0)	0 (0, 0)	*ns*	0 (0, 0)	0 (0, 1)	0.005
Attention/interaction cluster									
Approach	2 (1, 2)	2 (1, 2.7)	*ns*	5 (4, 6)	3 (2, 4)	0.005	5 (4, 5)	3 (3, 4)	0.01
Self-regulation	7 (5, 8)	6.5 (5, 8)	*ns*	4 (3, 4)	3.5 (2.2, 4.7)	*ns*	4 (3, 4)	5 (3.5, 6.5)	0.01
Stress	1 (1, 3)	2 (1, 4)	*ns*	0 (0, 0)	0 (0, 1)	*ns*	0 (0, 1)	1 (1, 2.5)	0.03
IBA sum									
Approach	9 (6, 11)	7 (5, 9)	*ns*	15.5 (14, 17)	12 (10, 13)	0.001	19 (16, 20)	15 (12, 17)	0.001
Self-regulation	15 (12, 16)	15 (12, 18)	*ns*	11 (8, 12)	11 (7.5, 13)	*ns*	12 (10, 13)	14 (13, 17)	0.003
Stress	8 (6, 11)	12.5 (8, 14)	0.047	3 (2, 4)	5 (3, 7)	0.02	2 (1, 4)	5 (3, 8)	0.001

[a]Mann–Whitney *U* test (two-tailed). C25, C75 are centiles; *ns*, not significant.

that the intervention infants were able to draw readily upon self-regulatory strategies during the course of the task as they displayed approach behaviours, accompanied with only few stress behaviours, especially after the third month of life. The infants in the control group continued to be poorly organized. Their self-regulatory behaviours resulted in increased approach behaviours as well, but to a lesser extent. Moreover, stress decreased to a lesser extent in all subsystems. At 6 months of age, we assume that approach and self-regulating behaviours of the infants in the control group were more at the expense of their energy and subsystem functioning. This may have negatively influenced their explorative experiences and may have affected infants' energy, motivation, and indirectly their development. The expectation that early neurobehavioural problems persist and become more exaggerated over time, especially in children from families in disadvantaged socioeconomic circumstances or less favourable home environments, have often been described (Weisglas et al. 1993, Shore 1997, Bronson 2000, Perlman 2001). Degangi (2000) followed a group of 22 infants with moderate-to-severe regulatory disorders, who fell within normal limits on the MDI of the BSID, from the age of 7 months. She studied the impact of the early regulatory problems of these infants on their later developmental outcome. Of these infants, 95% had delays in motor, language, and cognition development or parent–child relational problems at the age of 3 years. Early symptoms that were related to later problems included: poor self-regulation, inattention, tactile and movement hypersensitivities, problems with visual processing, and emotional/behavioural problems.

The Mother–Infant Transaction Program (Rauh et al. 1990), which is a comparable, brief, neurobehavioural intervention programme for low birthweight infants, starting during the final week of hospitalization and continuing in the home over a 3-month period, found significant intervention effects at 6 months in maternal role satisfaction, maternal self-confidence, and maternal perception of infant temperament, but no difference was found in infant mental development on the BSID at 6 and 12 months of age. In long-term follow-up studies, however, a significant and increasing divergence in cognitive development between the control and intervention group emerged from age 36 months to age 9 years (Achenbach et al. 1993). Unfortunately, we do not know if the Mother–Infant Transaction Program did boost the neurobehavioural competence of the infant at an early stage, thus enhancing later development, as this was not investigated. Understanding the underlying processes of development, e.g. self-regulation, may help us to adjust early intervention programs more effectively, to detect differences between groups at an early stage, and to identify those infants who need support most. In our study we mainly focused on the infant's behaviour, but we realize that the infant's neurobehavioural competencies are affected by many factors, in particular by parental stress. To evaluate the effect of the IBAIP it will be necessary to investigate parent and parent–infant interaction factors simultaneously with infant factors. Evidently, the durability of the early results in our study should also be evaluated in a long-term follow-up study.

Table III: Bayley Scales of Infant Development–II: psychomotor and mental index scores and behavioural scores in intervention (*n*=20) and control infants (*n*=20) at 3 months of age

Scale	*Intervention group Median (C25, C75)*	*Control group Median (C25, C75)*	p^a
BSID-II index			
Psychomotor	92.5 (88, 94)	79 (74.5, 82)	0.03
Mental	97 (93, 99)	91 (80, 96.5)	0.001
Behavioural centile			
Total	55 (41, 80)	16.5 (9.2, 29.2)	0.001
Attention/arousal	81 (71, 95)	56 (42, 88.5)	0.007
Motor quality	38 (21, 46)	11.5 (3, 15)	0.001

[a]Mann–Whitney *U* test (two-tailed). BSID-II, Bayley Scales of Infant Development–II (Bayley 1993). C25, C75 are centiles.

Table IV: Bayley Scales of Infant Development–II: psychomotor and mental index scores and behavioural scores in intervention (*n*=20) and control infants (*n*=20) at 6 months of age

Scale	*Intervention group Median (C25, C75)*	*Control group Median (C25, C75)*	p^a
BSID-II index			
Psychomotor	91 (88, 99)	77.5 (70, 88)	0.001
Mental	100 (96, 102)	88 (84, 101)	0.005
Behavioural centile			
Total	56 (38, 83)	14.5 (7.2, 24.2)	0.001
Orientation	72 (57, 90)	28 (21, 51)	0.001
Emotional/regulation	70 (46, 79)	30.5 (16.5, 54)	0.01
Motor quality	26 (15, 41)	5.5 (3, 9.5)	0.001

[a]Mann–Whitney *U* test (two-tailed). BSID-II, Bayley Scales of Infant Development–II (Bayley 1993). C25, C75 are centiles.

Conclusion

The results of this pilot study indicate that the Infant Behavioral Assessment and Intervention Program is a potentially useful program that may be advantageous in preterm infants, as it did not have detrimental effects on infants in this pilot study but reduced stress and increased self-regulatory competence at 6 months of corrected age. These promising results warrant further evaluation in a randomized controlled trial, with long-term follow-up.

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List of abbreviations

BSID-II	Bayley Scales of Infant Development – II
IBA	Infant Behavioral Assessment
IBAIP	Infant Behavioral Assessment and Intervention Program
MDI	Mental Developmental Index
NBAS	Neonatal Behavioral Assessment Scale
NICU	Neonatal Intensive Care Unit
NIDCAP	Newborn Individualized Developmental Care and Assessment Program
PDI	Psychomotor Developmental Index

Appendix 1

Case report

Infant A: born at 28 weeks weighing 975g, uncomplicated medical history, and at time of study was 42 weeks' gestational age and had been at home for 1 month.

Infant A lies against his mother's shoulder, covered with a woollen blanket. His mother looks tired. She reports to the interventionist that the baby is drinking well and gaining weight fast. He loves being held at the shoulder, but seems unsettled as soon as she puts him on her lap or places him on his back to change his diaper or to go to sleep in his crib. He cries a lot and is difficult to console. The interventionist confirms that she can see Infant A feels very safe and comfortable when held at her shoulder. He has a pink colour and breathes regularly; his head and hands rest in the crook of his mother's neck and his feet have found support in her pullover. He is not asleep but opens his eyes now and then to peek at his mother's face, as if he is curious whom she is talking to. His mother illustrates the problem by transferring the infant to a cradled position in her arms. As soon as mother lifts him from her shoulder he squirms and stretches his arms and fingers. He makes grunting sounds and turns red in his face. His mother holds him on one arm and tries to sooth him with a soft voice and by gently rocking and stroking with her other hand. The infant straightens his legs and pushes against mother's hand, he arches his back, his arms tremble, and he turns his tightly closed eyes away from his mother. The interventionist suggests that the baby may need much containment, like when held at his mother's shoulder. The pushing does not mean that he doesn't like being held but that he is seeking support. The interventionist helps the mother to bring the infant's legs to a tucked in position and to hold his feet. Then they swaddle him in a thin blanket with his hands free, so mother can offer her finger to the baby to grasp. This may help him to 'keep himself together' in this position. Interventionist and mother observe the infant without speaking, while mother is just holding instead of stroking and rocking. Infant A's movements calm down after some time and he regains his pink colour and regular breathing. His eyes are closed. After a while he opens his eyes, and his mother intuitively responds by greeting him with a smile, calling his name with a lively voice. The infant grunts, closes his eyes tightly, and stretches his arms away from his body as if he wants to say 'stop'. The interventionist explains that this was his way of saying that maybe there were too many things to look at and listen to all at once. The child's mother helps him to hold on to her finger again, and smiles quietly while he calms down and looks up to her face.