Title: The impact of optimality on maternal sensitivity in mothers with substance abuse and psychiatric problems and their infants at 3 months

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Abstract

The main aim of this study was to investigate the predictive validity of four different optimality indexes, as well as infant perinatal status, in relation to maternal sensitivity in interaction at 3 months. The four optimality indexes comprised items related to substance abuse, psychiatric condition, relational experience and socioeconomic status (SES). Maternal sensitivity in mother–infant interaction was assessed in two different groups of mothers. One group consisted of mothers with substance abuse and psychiatric problems who underwent treatment during pregnancy. The other group of mothers had neither substance abuse nor psychiatric problems. The expectant mothers were interviewed in the third trimester of pregnancy. Medical records and meconium were obtained from the infants at birth. Three months after birth, maternal sensitivity in mother–infant interaction was assessed. Altogether 79 mother–infant dyads participated in the study. The mothers’ optimality associated with relational experiences, as well as the infants’ perinatal status, were found to predict maternal sensitivity in mother–infant interaction at 3 months. The SES index was also significantly related to maternal sensitivity. The relation between group and maternal sensitivity was mediated by the mothers’ optimality associated with relational experiences. This study points to the importance of addressing the mothers’ own relational experiences and their current representations of motherhood during treatment, in order to support and enhance maternal sensitivity.
1. Introduction

Maternal sensitivity is an essential component of mother–child interaction, and refers to the mother’s awareness of the infant, and her ability to respond contingently to the baby’s signals, to read the infant’s cues and to structure the environment in accordance with the infant’s needs (Ainsworth, Blehar, Waters, & Wall, 1978). The concept of maternal sensitivity was inspired by John Bowlby’s attachment theory (1969), and further developed by Mary Ainsworth as a result of her studies of mother–child interaction (Ainsworth et al., 1978).

Maternal sensitivity is assumed to promote secure attachment between the infant and the parent (Biringen et al., 2005), while lack of sensitivity is found to be associated with later insecure attachment in the child (Espinosa, Beckwith, Howard, Tyler, & Swanson, 2001). Several studies report reduced maternal sensitivity and less affective involvement in mothers with substance abuse and psychiatric problems (Eiden et al., 2009; Luthar, D’Avanzo, & Hithes, 2003; Pajulo et al., 2001). These mothers have also been found to have problems affectively connecting with their infants and difficulties in attuning their own emotional responses to their babies (Hans, Bernstein, & Henson, 1999). A reduced capacity to read the infant's intentions (Hans, et al., 1999), as well as little enthusiasm, enjoyment and pleasure in interaction with their infants has also been reported (Burns, Chetik, Burns, & Clark, 1991, 1997).

The ability to respond appropriately to the infant’s signals is associated with the mother’s own relational history (Pajulo, Suchman, Kalland, & Mayes, 2006; Rodning, Beckwith, & Howard, 1991; Van Ijzendoorn, 1992). Mothers who experienced less sensitive caregivers in their own childhood may have internalized representations of others as rejecting and unreliable, and may feel less self-reliant and lovable. Unless adverse relational experiences have been resolved, these representations, or internal working models, are assumed to influence the
mother’s later relationship with her own child and to shape the transactions with the child (Suchman, McMahon, Slade, & Luthar, 2005). In line with this assumption, negative relational experiences in childhood and adolescence have been found to make mothers less sensitive and more susceptible to interpreting their infants' signals as rejection, and to view their infants more negatively (Johnson and Rosen, 1990; Pajulo et al., 2001). Mothers with substance abuse and psychiatric problems are reported to have a greater likelihood of previous difficult life events, exposure to violence (Amaro, Zuckerman, & Cabral, 1989) and more often to have been raised in families with biological relatives who suffer from psychiatric disorders than mothers without these problems (Rousanville et al., 1991).

A high comorbidity between substance abuse and psychiatric problems such as depression, anxiety and personality disorder, has been reported in several studies, (e.g. Espinosa, et al., 2001; Hans et al., 1999; Luthar, Cushing, Merikangas, & Rousanville, 1998; Weissman et al., 1999). Maternal depression is associated with poor maternal sensitivity and has been found to compromise the interaction between the mother and the infant (Field, 1995; Luthar et al., 1998; Weinberg & Tronick, 1998). Both proximal and distal variables are related to the developmental outcome of children born to mothers with substance abuse and psychiatric problems, and an environment containing few resources and several adverse factors may compromise the child’s development (Sameroff, 1998; Sameroff, Seifer, Baldwin, & Baldwin, 1993).

However, mother-infant interaction is dyadic and bidirectional. It involves both the mother’s ability to interpret and respond to signals from the baby, and the infant’s own capacity to modulate his states and be able to signal and respond to his caregiver (Tronick & Gianino, 1986). Several studies report that prenatal adversity (e.g. substances, stress, bad nutrition, etc.) increases the likelihood of premature birth, low birth weight, birth complications and small head
circumference (Hans, 1992; Lester 1998; Messinger et al., 2004; Moe, 2002; Moe & Slinning, 2001; Shankaran et al., 2004). Reduced growth measures at birth generally indicate increased biomedical vulnerability in these children, and a higher probability for behavioral dysregulation in infancy (Hans & Jeremy, 2001). A lack of sensitive parenting can exaggerate biomedical vulnerability and regulation problems in infants (Lester & Tronick, 1994).

The main aim of this study was to investigate more thoroughly which factors predict the ability to be a sensitive mother among women with different levels of optimality related to substance abuse, psychiatric condition, relational experience and socioeconomic status (SES). Therefore four different optimality indexes were computed based on the mothers' reports of past and present substance use, psychiatric condition, relational experiences in childhood and in the present, and socioeconomic status. The first index concerned maternal substance abuse. Substance abuse during pregnancy is associated with poor prenatal and postnatal environmental conditions for the child (e.g. Hans & Jeremy, 2001; Lester, Boukydis, & Twomey, 2000; Moe & Slinning, 2002). The second index was maternal psychiatric condition, which has been found to influence mothers’ abilities to be sensitive in interaction with their children, as well as their tolerance of stress (e.g. Espinosa et al., 2001; Hans et al, 1999; Luthar et al., 2003). The third index was relational experiences, which have also been found to impact later maternal affective involvement with the child, as well as attitudes regarding child rearing practices (e.g. Pajulo, et al., 2006; Suchman, et al., 2005; Van Ijzendoorn, 1992). The fourth index was related to socioeconomic status (SES), which comprises environmental factors that may impact the child’s developmental outcome (e.g. Lester et al., 2009).

The optimality concept was introduced by Prechtl (1980). This concept is based on the idea that it is easier to decide whether a condition is optimal rather than pathological. For
instance, it is easy to decide that no alcohol consumption during pregnancy is an optimal condition, but it is much harder to determine how much alcohol intake would comprise an unfavorable condition, and thus affect the fetus adversely. Optimality indexes are widely used in obstetrics and perinatal evaluation of infants born with a biological vulnerability (e.g. Optimality Index-US), and several studies demonstrate the usefulness of such indexes (e.g. Murphy & Fullerton, 2001; Perat, 1993; Seng, Mugisha, & Miller, 2008; Wiegers, Keirse, Berghs, & van der Zee, 1996). Optimality indexes consist of several items, and the sum of optimal conditions attached to the child and the environment is assumed to be a better predictor of the child’s outcome than an inherent medical condition. Hence, a higher sum of optimal conditions indicates more optimality, while more negative conditions yield a smaller sum of optimal conditions.

The main aim of this study was to investigate the predictive validity of four different optimality indexes (maternal substance abuse, psychiatric condition, relational experiences and SES), as well as infant perinatal status in relation to maternal sensitivity when the babies were three months old.

2. Method

2.1. Participants and procedure

To enhance the variability in background factors (especially those related to substance abuse, psychiatric condition, relational experience and SES), expectant mothers were recruited from different institutions for pregnant women: centers for families with substance abuse problems, a child psychiatric outpatient clinic, and well-baby clinics. The participants were followed from the third trimester of pregnancy until their babies were 3 months of age. For statistical purposes, the participants were divided into two groups. The women with substance abuse and psychiatric
problems comprised one group, and the women without any defined psychiatric or substance abuse problems served as a comparison group.

Data used in the present study was collected at three different points of time: during pregnancy, at birth and when the infants were 3 months old. The majority of the mothers were interviewed in the third trimester of pregnancy. The women were also asked to collect a meconium sample from their infants after birth. In addition, medical records from the hospital at birth were obtained. A video recording of the mother–infant interaction was obtained three months after birth.

Altogether, 92 mothers and 94 children (two pairs of twins) were enrolled in the study from December 2004 until January 2009. The inclusion criteria for the mothers with substance abuse problems specifically required that they were detoxified during pregnancy. A specific requirement for the mothers with psychiatric problems was admittance to psychiatric treatment during pregnancy due to mental health problems. The mothers in the comparison group were recruited from a non-clinical setting in order to minimize biomedical vulnerability and socioeconomic disadvantage. Inclusion criteria for all mothers in the three groups required that data had been registered from extensive interviews in the third trimester of pregnancy and that a video recording of the mothers’ interaction with their 3-month-old infants was available. In addition, the child’s medical record at birth had to be registered.

An exclusion criterion for the mothers with substance abuse problems was medical treatment with methadone or buprenorphine (subutex) during pregnancy. An exclusion condition for all mothers in the study was missed interviews in the third trimester of pregnancy. Exclusion criteria for the children were foster placement during the first 3 months of life and missed scheduled appointments when the infants were 3 months.
Altogether 77 mothers and 79 infants (39 girls) were eligible to participate in the current study. The data obtained during pregnancy was examined according to the number of mothers participating in the study (N = 77). The data taken at birth and when the infants were 3 months old was examined according to the number of infants participating (N = 79). Thus, two of the mothers (with twins) appeared twice in the analyses of mother-infant interaction since the mothers behavior in interaction will depend on the individual characteristics of each child. The group of mothers with substance abuse and psychiatric problems and their infants consisted of 49 infants (two pairs of twins) and 47 mothers (N = 49 at birth and at 3 months). The comparison group consisted of 30 infants and 30 mothers (N = 30).

The data obtained from the fathers was excluded due to the presence of many single mothers in the current sample, especially among the mothers who were treated for substance abuse problems.

The families were compensated for any travelling expenses, and each child was given a small toy or a book as a gift for participating in the study. The Norwegian Regional Committee for Medical Ethics approved the study. Informed consent from the parents was obtained at the time of enrolment.

2.1.1. Characteristics of the mothers recruited from treatment institutions for families struggling with substance abuse problems

Twenty-five women were recruited from different treatment institutions in Norway by employees who were also trained as research co-workers. Only one of the mothers was living at home and receiving help and support from an outpatient center for families at psychosocial risk.
The women were admitted into treatment at different points during pregnancy: six were admitted in the first trimester, nine in the second, and 11 in the third. The mothers’ average age was 26.2 years (min 17 years, max 40). A majority of the mothers (74.1 %) reported that they were living alone; the rest reported that they were living with a partner.

In the first trimester of pregnancy, 20 (80 %) of these mothers reported daily use of illegal substances, 11 (44 %) reported use 1-3 times a week and 17 (68 %) reported use 1-3 times a month. In the second trimester of pregnancy, 4 (16 %) of the mothers reported daily use of illegal substances, 3 (12 %) reported use 1-3 times a week, and 10 (40 %) reported use 1-3 times a month. In the third trimester of pregnancy, 2 (8 %) of the women reported daily use and 2 (8 %) of the mothers reported use 1-3 times a month. Daily, weekly or monthly alcohol consumption in the first trimester was reported by 9 (36 %) of the mothers. No alcohol consumption was reported in the second trimester, and only one reported drinking 1-3 times a month in the third trimester. Daily smoking was reported by 23 (92 %) of the mothers in the first trimester and 22 (88 %) in the second trimester. In the third trimester, 15 (60 %) of the women reported smoking daily.

The mothers’ use of substances was self-reported. Even if these women were institutionalized and detoxified during pregnancy, it was decided that a more objective measure of actual substance use should be obtained. Meconium can be used as a more objective indicator because the substances used by the mother are stored and accumulated in the meconium during the last part of pregnancy. Substances can be traced back to 16-20 weeks after conception (Lester et al., 2001; Tassiopoulos et al., 2010). The meconium analyses revealed that self-reports from the mothers in both groups were consistent with meconium content.
2.1.2. Characteristics of the mothers recruited from the child psychiatric clinic

Twenty-two women were enrolled from a child psychiatric center by employees who were also trained as research co-workers. The women were admitted to the child psychiatric center due to depression during pregnancy. One of the women was recruited from a child psychiatric outpatient center that offers treatment to pregnant women with psychiatric problems. The average age of the mothers was 30.1 years (min 21, max 38). The majority of the mothers were living with a partner (73 %), but six (27 %) reported being single. No use of illegal substances or narcotics was reported among these women. Weekly or monthly alcohol consumption was reported by 11 (50 %) of the mothers in the first trimester. In the second and third trimester 5 (23 %) and then 4 (18 %) of the mothers reported monthly alcohol consumption. Daily smoking was reported by 6 (27 %) of the mothers in the first trimester, and 5 (23 %) in the second trimester. Four (18 %) of the mothers reported daily or weekly smoking during the third trimester of pregnancy.

2.1.3. Characteristics of the mothers recruited from well-baby clinics

Thirty families were recruited from local well-baby clinics in Oslo, which are optional, non-clinical settings that provide services free of charge. The average age of the mothers was 33.3 years (min 27, max 44). All of the mothers reported that they were living with a partner.

No use of narcotics was reported among these women. Weekly or monthly alcohol consumption was reported by 21 (70 %) of the mothers in the first trimester. In the second and third trimester 7 (23 %) and then 4 (13 %) of the mothers reported alcohol consumption 1-3 times a month. Daily or weekly smoking was reported by 3 (10 %) of the mothers in the first trimester. Only one of the mothers reported smoking during the second and third trimester of pregnancy.
2.2. Measures in the third trimester of pregnancy

Interviews with the mothers were conducted in the third trimester of pregnancy to get information about age, civil status, education, employment, living conditions, alcohol consumption and medication, drug abuse, somatic health, psychiatric status, criminal offences, social network and relational experiences.

The main interview was based on the questionnaire European Addiction Severity Index (EuropASI), Fifth Edition, (Kokkevi & Hartgers, 1995; McLellan, et al., 1992). The European Addiction Severity Index (EuropASI) was translated into Norwegian by Leif Hidle, Grethe Lauritzen and Astrid Skretting (1997), and back translated. The back translation was accepted by the Amsterdam Institute for Addiction Research. The EuropASI consists of numerous questions related to different areas of functioning, such as physical health, work and income, alcohol, illegal drugs and medication, criminal offences, family and social relations and psychiatric condition.

Two additional questionnaires designed for the present study in order to obtain information in areas not covered by EuropASI were also administered. The first comprised questions related to childhood experiences, family relations and social support. The other questionnaire, Questionnaire for Pregnant Women, consisted of items related to earlier pregnancies, medically assisted rehabilitation, and provided a more thorough assessment of the use of nicotine, drugs, and alcohol during pregnancy, as well as healthcare received.

In order to investigate the presence of other psychiatric problems, Millon’s Clinical Multiaxial Inventory - III (MCMI-III) was also administered. MCMI–III is constructed as a list of 175 common statements about attitudes and feelings, and each statement is scored as true or false. The scores yield measures on five scales: clinical personality patterns, severe personality
pathology, clinical syndromes, severe clinical syndromes and modifying indexes (Millon, Millon, Davis & Grossman, 1997). The forms were scored with a database program called Q–Local. A short version of the *Hopkins Symptom Checklist, SCL-25* (Derogatis, Lipman, Rickels, Uhlenhut, & Covi, 1974) was also administered as an assessment of depression and anxiety. The SCL-25 is a self-administered questionnaire. It consists of 25 items, each rated on a four point scale ranging from 1 (not at all) to 4 (extremely) (Strand, Dalgard, Tambs, & Rognerud, 2003). Ten of the questions are related to symptoms of anxiety, and 15 of the questions are related to symptoms of depression.

2.2.1. *The construction of four cumulative optimality indexes*

The information obtained in pregnancy from the interviews and questionnaires described above was used to construct four indexes of optimality. These four indexes were, as mentioned in the introduction, based on clinical knowledge and research regarding important maternal and environmental factors that have been shown to impact children’s development. The items used to construct the optimality indexes were dichotomized as either optimal or non-optimal. Conditions that were considered to be optimal were scored as 1 point, while non–optimal conditions were scored as zero. Optimal conditions are, for instance, abstaining from smoking, alcohol and other substances, living with the baby’s father, having more than 12 years of education, absence of psychiatric problems and being employed. If all the questions in a particular index were scored as optimal, the maximum optimality score was equivalent to the number of questions comprising the index. Likewise, absence of optimality conditions related to a particular index will give the least optimality score (zero points).
The first index concerned maternal substance abuse. This index consisted of 33 questions about debut and recent use of alcohol and illegal substances (e.g. cannabis, amphetamine, opiates, poly substance), and experienced overdose or delirium tremens. A maximum optimality score (sum score = 33) was obtained if no use of substances was reported. The second index, maternal psychiatric condition, comprised 34 questions based on reported psychopathology as measured by the MCMI-III, anxiety and depression as measured by the SCL-25, and some questions from the EuropASI. Symptoms associated with psychiatric or personality disorders were dichotomized as optimal or non-optimal according the clinical cut-off point (75) as defined in the MCMI-III manual (Million et al., 1997). Symptoms below the cut-off point were defined as optimal (1 point), while the symptoms above it were scored as non-optimal (zero points). Symptoms of anxiety and depression (SCL-25) were scored as optimal or non-optimal according to a cut-off point of 1.75. This same scoring has been used in several other studies (e.g. Karlsson, Joukamaa, & Lehtinen, 2000; Nygård, Klungsøyr, Sandanger, & Svensson, 2009; Strand et al., 2003). A sum score less than 1.75 for anxiety and depression was scored as optimal, while a sum equal to or above the cut-off point was scored as non-optimal. Questions regarding psychiatric treatment, hospitalization, medication and suicide attempts (EuropASI) were scored as optimal if no psychiatric interventions were reported, and as non-optimal if treatment was received. The third index concerning relational experiences had 10 questions. Four of the questions dealt with former and present relationships with parents, siblings, partners or other significant relatives. (“Have you over time experienced major problems in relation to your mother, father, partner, siblings or other significant relatives - the last 30 days or earlier in life?”). Three of the questions were related to experience of emotional, physical or sexual abuse. (“Have any of these people abused you emotionally, physically or sexually – the last 30 days or earlier in life?”). Three
additional questions were also included in this index. Two of them were related to childhood experiences ("Were you or your family at any point in contact with the child protection service?", "Did you have problems that were specifically related to school?"), while the third question concerned present status as a caregiver ("Number of other children that are taken care of by other caregivers?"). These ten questions were scored as optimal if no problems were reported, or as non-optimal if any relational problems were reported. The fourth index, *socioeconomic status*, consisted of seven questions on topics like education, work and income. Examples of conditions that were scored as optimal included education beyond high school, steady employment, adequate income etc.

The construction of indexes like these has been reported to be an effective method of data reduction when dealing with many variables and relatively small sample sizes (Burchinal, Roberts, Hooper, & Zeisel, 2000).

2.3. Measures at birth

To obtain information about the infants' medical status at birth, including gestational age, birth weight and neonatal abstinence syndrome, medical records from the hospitals where the mothers gave birth were collected. Since all of the mothers with substance abuse problems were institutionalized during the last trimester of pregnancy, none of the children evidenced abstinence symptoms after birth.

As described earlier, the mothers were asked to collect the first meconium from their newborn infants in order to get an objective measurement of maternal substance use during pregnancy. Meconium is the first stool passed by the infant after birth (Lester et al., 2001;
Prior to birth, the mothers were given a test tube to collect the meconium, and a consigned envelope. The samples were then sent to St. Olavs hospital in Trondheim, where they were frozen while awaiting analysis. Meconium samples were collected from 62 (78 %) of the infants. At the time of analysis three of the samples had disappeared, and another three samples contained too little meconium and to be analyzed. Altogether 56 (71 %) of the meconium samples were analyzed.

2.4. Measures when the infants were 3 months

Mother–infant interaction was video recorded at 3 months. The mothers were asked to play with the child as they wished, and they had access to a basket with age-appropriate toys. The interaction between mother and child was assessed by a global interaction analysis based on the Parent-Child Early Relational Scale (PCERA) coded from five minutes of free play on the floor (Clark, 1985) as part of a longer observation. The Parent–Child Early Relational Assessment (PCERA) (Clark, 1985) is a video-based, parent-child assessment method that aims to capture the strengths and areas of concern in the parent, the child and the dyad. The variables are rated according to the frequency, duration and intensity of the observed behavior (Clark, 1985, 2006). The discriminative validity of this method has been established by demonstrating differences between dyads in high-risk groups and non-risk groups (Clark, 1999, 2006). The PCERA consists of 65 variables that are clustered into different parent, child and dyadic scales, respectively. As the scope of this study was to investigate maternal sensitivity in interaction at 3 months (as well as predictors associated with this variable), it was decided to use the scale maternal affective and behavioral involvement from the PCERA as a measure of maternal sensitivity. The scale consists of several items including the quality and amount of physical
contact, visual contact and verbalization. It also measures the caregiver’s social initiative, actions to structure and mediate the environment, ability to read the child’s cues and respond appropriately, level of connectedness and mirroring, and contingent responsivity to the child’s positive or age-appropriate behavior. (Contingent responsivity to the child’s perceived negative or unresponsive behavior could not be scored in the present study). Several of these items from the PCERA are also included in Ainsworth’s et al (1978) definition of maternal sensitivity (parent’s availability, attentiveness, appropriate and contingent responses, ability to read the infant’s cues, and to structure the environment in interaction). Other studies investigating maternal sensitivity in interaction have also used items from the scale maternal affective and behavioral involvement (PCERA) as a measure of maternal sensitivity (e.g. Harel, Oppenheim, Tirosh, & Gini, 1999; Kivijärvi et al., 2001).

Each item is rated on a five-point Likert scale. Values 1 and 2 are defined as areas of concern, value 3 indicates some concern, and 4 and 5 are defined as areas of strength. Since the five values can be placed into three areas of concern, the five-point scale was collapsed to three main categories; areas of concern (1=2), areas of some concern (3) and areas of strength (4=5) for coder agreement reliability. Scoring of the interaction pattern was done by two coders who were highly experienced in coding PCERA and were blind to the participants' group allocation, and not acquainted with the participants. In order to evaluate coder agreement, 20 percent of randomly selected tapes were coded by the two independent raters. A high inter-rater reliability (intra class correlation = .84) was found on the main dependent variable, maternal affective and behavioral involvement. The internal consistency for this subscale was high (Cronbach α = .91).
2.5. Statistical analyses

Group differences were analyzed by using independent samples t-tests. The groups were compared on maternal sensitivity (i.e. the outcome variable), and on the four optimality indexes, the child’s birth weight and gestational age (i.e. the predictor variables). Bivariate correlations were used to investigate the inter-relations between the four optimality indexes, the infants’ birth weight and gestational age (the independent variables), as well as the correlation between maternal sensitivity (the dependent variable) and the independent variables. A hierarchical regression analysis was also conducted. In the regression analysis, maternal sensitivity in mother-infant interaction served as the dependent variable, whereas gestational age and the optimality of the mothers' relational experiences were entered as predictor variables. Finally, mediation analyses were conducted using linear regressions in four steps as outlined by Baron and Kenny (1986). Four conditions must be met to confirm a mediation model. First the predictor variable (group) must significantly correlate with the outcome variable (maternal sensitivity) to establish that a path can be mediated. Second, a significant correlation between the hypothesized mediator (relational experience) and the predictor variable must be established. Third, the possible mediator must be significantly related to the dependent variable. Fourth, a reduced effect of the predictor on the dependent variable after the mediator variable is controlled for must be established. If all four conditions are met, then data are consistent with the hypothesis that the mediator variable completely mediates the relationship between relational experience and maternal sensitivity. If the three first conditions are met but the last one is not, then partial mediation is indicated.

The significance level was set to $p \leq .05$. All analyses were performed using SPSS 16.0.
3. Results

3.1. Group differences

Analysis with independent samples t-tests revealed that the difference in maternal sensitivity between the group with substance abuse and psychiatric problems and the comparison group was statistically significant (p<.05). The effect size calculated by Cohen's d was moderate (d=.48).

Further, independent samples t-tests revealed significant differences between the group with substance abuse and psychiatric problems and the comparison group on maternal sensitivity, the four optimality indexes and the infants’ birth status (i.e. the predictor variables) (see Table 1).

3.2. Relations between the predictor variables and maternal sensitivity in mother-infant interaction at 3 months

The bivariate correlations between maternal sensitivity and the optimality indexes related to the mothers’ substance abuse (p>.10) and psychiatric condition (p>.10) were not statistically significant. The mothers' optimalities associated with relational experiences and SES were both found to be significantly related to maternal sensitivity in interaction at 3 months (see Table 2). The correlation between infant birth weight and maternal sensitivity did not reach statistical significance. However, gestational age was found to be significantly related to maternal sensitivity in interaction. The pattern of inter-correlations between the predictor variables was investigated for their usefulness in the hierarchical regression analysis presented below (see Table 2).
3.3. Hierarchical regression analysis of maternal sensitivity predicted by group, perinatal status and the mother’s relational experiences

A hierarchical regression analysis was conducted to examine the predictive validity of the independent variables in relation to maternal sensitivity. Since relational experiences have more psychological significance in relation to maternal sensitivity than SES, which is a more distal demographic variable, the optimality of the mother’s relational experiences was used as a predictor variable in the regression equation. The SES index was also highly correlated with group \( r = .72, p < .001 \), and was thus a redundant variable in addition to group. The perinatal variables (i.e., gestational age and birth weight) may be conceived as markers of prenatal events and possibly constitute increased biomedical vulnerability among children born to substance abusing women. Birth weight was not significantly related to maternal sensitivity (see Table 2), and therefore only gestational age was used as an indicator of the child’s biomedical condition at birth in the further analyses. Finally, group, the optimality index associated with the mother’s relational experiences and the infant’s gestational age were selected as the independent variables in the regression model. Maternal sensitivity acted as the dependent variable.

Group was entered in the first step of the equation. Infant gestational age was entered in the second step. In the third step, maternal relational experience was entered. As shown in Table 3, group contributed significantly to the prediction of maternal sensitivity in the first step, explaining six percent of the variance. This variable was no longer significant when infant gestational age was entered. The regression analysis showed that both infant gestational age and maternal relational experience made a significant contribution to the prediction of maternal sensitivity. Based on \( \Delta R^2 \) estimates, infant gestational age added five percent of the explained variance in the second step, and maternal relational experience accounted for another five
percent of the explained variance in the third step. In the final model, the explained variance was 16 percent.

3.4. Mediation analysis

As shown above, the effect of group on the dependent variable was substantially reduced when the independent variables were entered into the regression equation. To investigate whether the index associated with relational experiences or gestational age would mediate the association between group and maternal sensitivity, two mediation analyses based on Baron and Kenny’s model (1986) were computed. To test if the optimality index associated with relational experiences would meet the three first criteria of the mediation model, linear regressions were conducted. In linear regressions conducted to test the three first criteria of the mediation model, group explained five percent of the unique variance in maternal sensitivity ($\beta = -.23, p < .05$) and 44 percent of the unique variance in relational experience ($\beta = -.66, p < .001$). Relational experiences explained nine percent of the unique variance in maternal sensitivity ($\beta = .33, p < .05$). In a multiple regression to test the fourth step in the mediation analysis, the variance in maternal sensitivity accounted for by group was substantially reduced ($\beta = -.02, p > .08$) when relational experiences were added to the mediation model (see figure 1). This result implies that the three first criteria for the mediation model are met, but as the effect of group did not totally disappear, the fourth criterion indicates that a partial mediation has occurred. In the second mediation analyses conducted to examine whether gestational age could act as a mediator, the three first criteria for the mediation model were met. The fourth criterion was not met, and hence gestational age was not found to act as a mediator.
4. Discussion

The present study investigated how maternal sensitivity in mother–child interaction assessed at 3 months was related to the level of optimality associated with substance abuse, psychiatric condition, relational experiences, SES and infant perinatal status. Mothers recruited from institutions for pregnant women with substance abuse problems, from child psychiatric outpatient clinics, and from well baby clinics, were followed from pregnancy until their children were 3 months old. Maternal sensitivity in interaction at 3 months was significantly predicted both by the maternal optimality index associated with relational experiences and infant gestational age. Moreover, the optimality index associated with relational experiences was found to mediate the association between group and maternal sensitivity.

As expected, maternal sensitivity was significantly lower in the group of mothers with substance abuse and psychiatric problems than in the comparison group. This result is supported by other studies that report reduced maternal sensitivity in mothers with substance abuse and psychiatric problems (Pajulo et al., 2001). However, the present study suggests that the association between group and maternal sensitivity was mediated by maternal optimality associated with relational experiences. This indicates that group differences in maternal sensitivity may be caused by differences in the mothers’ positive or negative internalized representations of mother–infant interaction based on their relational experiences. Low optimality on the relational-experiences index reflects negative experiences in close relationships during childhood and adolescence as well as in present relationships with the partner, parents and siblings. It is emphasized that the relational optimality index did not measure internal working models or internalized representations by using an attachment assessment method. However, the direct questions asked about former and present relationships that were used to construct this
index probably capture essential information that influences the mothers’ internal representations, and subsequently their ability to be sensitive in interaction with the infants. An association between relational experiences and the capacity to be sensitive in interaction with the infants has also been found in other studies of mothers with substance abuse and psychiatric problems (e.g. Luthar & Walsh, 1995; Suchman, DeCoste, & Mayes, 2009). These mothers are often reported to have had a high incidence of relational difficulties and psychosocial problems (Pajulo et al., 2006; Savonlahti et al., 2005; Suchman et al., 2005). A personal history of lack of caring relationships may impact a mother’s mental representations of being a parent (Luthar & Walsh, 1995), and bring about misinterpretations of the infant’s cues (Suchman, et al., 2009). Lack of sensitive caregiving during childhood may create internal working models and induce mental representations of others as dismissive, as well as feelings of worthlessness. These representations are assumed to be acted out in relation to her own child when the woman becomes a mother, and to influence her ability to be sensitive in interaction with the child (Suchman, et al., 2005). Hence, the mother’s representations of motherhood ought to be addressed in a therapeutic setting to cause resolution of her own difficult feelings and thoughts and increase her sensitivity and emotional availability (Suchman et al., 2009; Suchman, Mayes, Conti, Slade, & Rounsaville, 2004). Pajulo et al. (2006) point to the importance of starting treatment of women with substance abuse and psychiatric problems during pregnancy by working with the mother’s internal representations, images and feelings about the future baby in order to heighten the mother’s awareness of the unborn child and her reflective functioning, as well as her ability to understand the child’s intentions. After birth, the intervention should be focused on the emotional connection between the mother and the infant.
As expected, the optimality index related to SES was also found to be significantly associated with maternal sensitivity in interaction, although this variable was not used in the regression analysis due to the fact that SES was highly correlated with group. SES is an overarching variable that mainly comprises distal factors in the environment. Low SES is commonly associated with low income, parents with less education, single parenting, lack of social support and other environmental stressors (Beeghly & Tronick, 1994; Hans et al., 1999; Hans & Jeremy, 2001). In this perspective, SES can be conceived as a marker variable for the postnatal environmental conditions among children of mothers with substance abuse and psychiatric problems. It indicates that these mothers are facing several challenges in addition to the substance use and psychiatric problems per se (Lester et al., 2009). Problems related to low SES and daily life struggles ought to be considered in treatment, as well as the opportunity to get an education and employment later in life.

In addition to the level of optimality, maternal sensitivity was also found to be affected by infant characteristics. Lower birth measures were found in the group of infants born to mothers with substance abuse and psychiatric problems than among the infants in the comparison group. This finding implies the presence of higher biomedical vulnerability among the children born to mothers with substance abuse and psychiatric problems, despite the treatment these women had received during pregnancy. Reduced optimal perinatal status in the infants born to mothers with substance abuse and psychiatric problems suggests that several factors, such as prenatal substance exposure in the first trimester (before admission into treatment), smoking, maternal stress and psychiatric difficulties may have influenced the intrauterine environment and the prenatal growth of these infants (Dixon, 1994; Hans, 1992; Moe & Slinning, 2002). Perinatal status is a marker of prenatal conditions, and lower measures at birth may indicate an elevated
constitutional sensitivity in the child. Heightened biomedical vulnerability has been shown to increase the likelihood of regulation problems in infancy, and a higher reactivity in the four A’s of infancy: attention, arousal, affect and action (Lester & Tronick, 1994). The infant’s capacity to cope with sensory impulses from the environment (Schuetze, Eiden, & Coles, 2007) is accomplished through interaction with the caregiver. A mother with poor sensitivity may reduce the infant’s own capacity to regulate affect in situations of stress (Eiden et al., 2009), and the ability to self-soothe (Papousék, 2008). According to the transactional model (Sameroff, 2009; Sameroff & Mackenzie, 2003), the interaction between an infant born with biomedical vulnerability and a mother with poor maternal sensitivity may escalate into more detrimental interaction patterns over time.

Surprisingly, the optimality index related to substance abuse problems was not found to be significantly associated with maternal sensitivity in interaction at 3 months. This may be due to the fact that the mothers with substance abuse problems had undergone treatment and were all abstaining from using drugs when the child was 3 months old. Moreover, the interval between the two time points may have been too short to detect such an association. It is plausible that the impact of maternal substance abuse and psychiatric problems will be more evident over time as the child develops and poses new challenges to the mother’s parenting capacity.

It is also noteworthy that the optimality index related to psychiatric condition was not found to be significantly related to maternal sensitivity. One possibility is that the present mothers were able to be sensitive to their children during the interaction, despite their psychiatric problems (cf., Campbell et al., 2004). Another possibility is that mothers struggling with substance abuse problems underreport their actual rate of mental health problems. These mothers may consider dependency as their primary problem, and may have used drugs to subdue
psychiatric symptoms or other painful experiences. This might have lowered the awareness of
their own internal mental state and feelings, and led to reduced mentalization ability and an
underreporting of depression and other psychiatric symptoms (Amaro et al., 1989; Fonagy,
2006).

The present study has limitations that need to be addressed in future research. The
participants were given extensive interviews and questionnaires concerning anxiety, depression
and personality disorders. However, a more extensive diagnostic psychiatric evaluation in
addition to the self-report might have yielded a stronger association between psychiatric
condition and maternal sensitivity. Also, the assessment of relational experiences might have
been strengthened if an extensive interview of the mothers’ internal working models or another
attachment measure had been included in addition to the questions used to construct the
optimality index associated with relational experiences. Unfortunately this was outside the
original scope of the present study.

The mothers’ awareness of being taped may have affected their interaction with the
infants and might not accurately reflect their actual interaction with their babies in daily life. On
the other hand, the tapes were scored by two experienced clinicians who were blind to the
background of the participants and had a high interscorer agreement.

5. Conclusions

The present study suggests that substance abuse and psychiatric difficulties in expectant mothers
are associated with reduced maternal sensitivity in interaction with their infants. However,
进一步 examination revealed that the mothers' ability to be sensitive in interaction with their
children was mediated by the optimality associated with relational experiences. The optimality of
the mothers’ relational experiences points to the importance of psychological processes and
possibly reflects maternal availability of positive or negative internalized representations of
mother–infant interaction based on the mothers relational experiences. It was also found that the
optimality index related to SES was significantly associated with maternal sensitivity in
interaction. This suggests that the mothers in this study were facing several challenges in
addition to substance use and psychiatric problems. In addition to the mothers’ level of
optimality, maternal sensitivity was affected by infant characteristics, specifically the infants'
perinatal status.

The present findings demonstrate the necessity of intervention during pregnancy and
eyear infancy among women with problems related to substance abuse and psychiatric problems.
In order to support and enhance maternal sensitivity, a comprehensive treatment setting must
consider the mother’s drug dependency and psychiatric problems, as well as the mother's own
relational experiences and her current representations of motherhood. Contextual conditions
associated with daily living, such as economy and education should also be targeted in a
multifaceted treatment model.

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