THE DEVELOPMENT OF INFANT TEMPERAMENT AND ITS RELATIONSHIP WITH MATERNAL TEMPERAMENT

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The present study explored the longitudinal relationship between infant temperament and maternal characteristics including depression and temperament, as well as the developmental change and stability of infant temperament. Assessments by questionnaires were conducted at 3 (N = 55), 10 (N = 51), and 16 (N = 52) months for infant temperament; at 1 month before and after delivery for maternal temperament; and at 1 month after delivery for maternal depression. Maternal temperamental characteristics significantly predicted infant temperament, but depression did not. Maternal Negative Affectivity predicted infant Negative Affectivity at 3 months, and maternal Orienting Sensitivity predicted infant Regulatory Capacity/Orienting at 10 months. Infant Positive Affectivity/Surgency significantly predicted infant later Regulatory Capacity/Orienting. Infant temperament showed developmental stability as individual differences as well as developmental changes as a group. The results are discussed with respect to genetic and environmental influences on infant temperament.

Key words: infant temperament, maternal temperament, maternal depression, longitudinal study, parent-report

INTRODUCTION

Beginning with the pioneering works of Thomas and Chess (Thomas, Chess, Birch, Hertzig, & Korn, 1963), via a roundtable discussion entitled “What is temperament? Four approaches” (Goldsmith et al., 1987), the amount of research on temperament has rapidly increased. As a result, temperament has been found to have significant effects on many aspects of children’s own development and others’, and many researchers have begun to explore factors influencing temperament and its development (Kagan et al., 1994; Kochanska, 2001; Paulussen-Hoogeboom, Stams, Hermanns, & Peetsma, 2007). Among them, maternal mental health, especially depression, was intensively studied because of its clinical importance, and was shown to have consequences for children’s development of negative and positive emotions (Bridgett et al., 2009; Huot, Brennan, Stowe, Plotsky, &
Walker, 2004; Pauli-Pott, Mertesacker, & Beckmann, 2004).

Given that depression is closely connected with personality traits, however, it is taken for granted that a mother’s personal traits have influences on the child’s temperament and its development. In addition, considering that infant temperamental traits are the affective core of adult personality traits, a genetic relationship between parental personality and infant temperament is naturally expected to some extent. Some studies actually indicate that most adult personality traits are moderately heritable, based on evidence from twin and adoptee studies (Goldsmith, 1983; Jang, Livesley, & Vemon, 1996). Recently, some researchers have begun studying the relationship between a child’s temperament and the mother’s personality. For example, there were findings linking a child’s temperament to maternal anxiety, which is one of the personality traits (Austin, Hadzi-Pavlovic, Leader, Saint, & Parker, 2005; Coplan, O’Neil, & Arbeau, 2005). However, the maternal characteristics these studies addressed were only negative aspects such as anxiety. On the other hand, Rickman and Davidson (1994) assessed personality traits such as extraversion in parents of children categorized as behaviorally inhibited or uninhibited and showed the differences between them. However, the only children’s temperamental characteristic they focused on was behavioral inhibition/uninhibition. There are few studies examining the relationships between children’s temperament and maternal personality traits in a comprehensive manner.

One of the reasons the relevance between maternal personality traits and a child’s temperament has not been comprehensively investigated is that no instruments have been developed to measure the temperament of both parent and child based on the unified theory of temperament for adult and child. Fortunately, a series of temperament questionnaires that measure the same temperament constructs from infancy to adulthood based on the inclusive temperamental theory has been previously developed by Rothbart and her colleagues. In their definition, temperament is “constitutional differences in reactivity and self-regulation, with ‘constitutional’ seen as the relatively enduring biological makeup of the organism influenced over time by heredity, maturation, and experience” (Rothbart & Derryberry, 1981, p. 37). Their questionnaires for infant, child, adolescent, and adult can assess about a dozen subscales of temperament, which were demonstrated to constitute three or four factor scales, even with minor differences across ages (Putnam, Ellis, & Rothbart, 2001). However, there have been few studies examining the association between temperament of mother and infant using these questionnaires. Thus, using these questionnaires, we conducted a family study about temperament of mothers and infants.

First, we examined the relevance of each similar dimension of temperament between mother and child, because it was presumed that there would be a genetic transmission in a similar dimension of temperament between mother and child. Recently, it has been revealed that genes contribute to temperament and personality in molecular personality genetics (Ebstein, 2006). For example, it was indicated that genetic variation biases specific mechanisms, giving rise to individual differences in temperament (Grossmann et al., 2011). As both the Adult Temperament Questionnaire (ATQ; Rothbart, Ahadi, & Evans, 2000) and the Infant Behavior Questionnaire-Revised (IBQ-R; Gartstein & Rothbart, 2003) include similar factor scales based on the same temperament theory, we
are able to examine comparable factor scales between mother and child.

However, it is insufficient to examine relationships between only the comparable dimensions of mother and infant, because the relevance between the mother’s and the child’s temperament is not due only to the genetic effect. Maternal characteristics could play an important role as the social environment. Second, therefore, we also examined the relationships between different dimensions of maternal and child temperament. Thus far, some evidence for influences of maternal positive emotion on the child’s effortful control and the infant’s negative emotion has been reported (Gartstein, Bridgett, Young, Panksepp, & Power, 2012; Mangelsdorf, Gunnar, Kestenbaum, Lang, & Andreas, 1990; Valiente et al., 2006).

We longitudinally examined these relationships between mother and child temperament noted above at various different points during infancy. Longitudinal behavioral genetic studies of early temperament development are rare in twin studies (Saudino, 2005). Longitudinal family studies are still rarer. The phenotypes of temperament change rapidly during infancy (Sroufe, 1996), although individual differences in temperament are supposed to be relatively stable. Not all genes involved in the expression of temperament might continue to be expressed from birth. Furthermore, it was proposed that naturally occurring variations in maternal behavior could alter the expression of genes that regulate an infant’s behavior (Meaney, 2001, 2010). Since environmental influences are accumulated with increasing age, it is supposed that the hereditary effect of maternal temperament shows a gradual decline. Therefore, the relationships among them could change over time. It is important to investigate how associations between maternal and child temperament change or do not change as a child develops.

Third, we explored the longitudinal relationships among factors of infant temperament. According to Rothbart’s framework of temperament (1989), an infant’s self-regulatory process is assumed to modulate the positive and negative affective reactions of infants, and vice versa. There has been no study examining the relationship between self-regulation and reactivity, developmentally.

Forth, we explored other influencing factors on an infant’s temperament development including maternal depression, difficulties with parenting, and husband support. Concerning the maternal depression, we ascertain the result mentioned earlier that maternal depression has a significant effect in the development of the child’s temperament. As husband support and parenting difficulties were pointed out to relate to parenting behavior (Cnric, Greenberg, Ragozin, Robinson, & Basham, 1983; Teti & Gelfand, 1991), they could have effects on development of infant’s temperament via parenting behavior. Whereas previous studies of parenting difficulties have obtained results that children’s temperament had influences on maternal parenting difficulties and/or parenting stress (Cutrona & Troutman, 1986; Honjo et al., 1998; Porter & Hsu, 2003), no researchers have examined the reverse effect, that is, from parenting difficulties to children’s temperament. Given the fact that the number of mothers with parenting difficulties recently increased in Japan, it is important to examine this effect.

Finally, we also addressed the basic issues, that is, developmental change and stability of temperament using the IBQ-R. Until now, there have been no studies on the IBQ-R
using a Japanese sample except for Nakagawa and Sukigara (2005) who have reported
cultural differences in factor patterns between Japan and the United States. As their sample
was not longitudinal, their results concerning developmental changes were based on a
cross-sectional sample. We will explore developmental changes and stability using the
data of a longitudinal sample.

**Method**

**Participants**

Pregnant women were recruited via the Healthy Maternity Seminar organized by the Japanese
Foundation of Mother-Child Health. Fifty-eight women agreed to participate in our longitudinal project
(Sapporo Longitudinal Study on Cross-Contextual Development). The age of the mothers at the time of
pregnancy was 22 to 42 years (mean = 30.8). No mothers had any clinical problems, and none of the infants
had experienced any serious birth complications or had congenital anomalies.

All questionnaires were handed to mothers at home visits and completed questionnaires were collected
at the next home visit by research assistants. The number of questionnaires collected was as follows: 58 at
1 month before delivery, 57 at 1 month after delivery, 55 (28 boys and 27 girls) at 3 months (mean = 2.9), 51
(25 boys and 26 girls) at 10 months (mean = 10.7), and 52 (26 boys and 26 girls) at 16 months (mean = 16.1).
The number of participants decreased with age, due to moving and so on.

**Maternal measures**

The questionnaire we used to assess maternal temperament was the Japanese version of the ATQ short
form (Rothbart et al., 2000) translated by the first author and her colleague (Hoshi & Kusanagi, 2012). The
ATQ short form is composed of 77 items and measures the same 13 temperamental subscales as the ATQ long
form: Fear, Sadness, Discomfort, Frustration, Inhibitory Control, Activation Control, Attentional Control,
Sociability, High Intensity Pleasure (High Pleasure), Positive Affect, Neutral Perceptual Sensitivity (Neutral
Sensitivity), Affective Perceptual Sensitivity (Affective Sensitivity), and Associative Sensitivity. These
subscales constitute 4 over-arching factor scales: Negative Affectivity, Effortful Control, Extraversion/
Surgency, and Orienting Sensitivity (see Appendix A).

The ATQ items are rated on a seven-point scale ranging from 1 (extremely untrue), 4 (neither true nor
false), to 7 (extremely true), and X (not applicable). Subscale scores for the ATQ were computed by averaging
all numerical item responses for a given subscale. When a mother omitted an item, or checked the “X”
response option for an item, that item was not included. To score factor scales, item scores for all subscales
belonging to a given factor scale were added and then divided by the number of items receiving a numerical
response.

While maternal temperamental characteristics are conceived to be stable over time, it is possible that
maternal characteristics change across the period before and after delivery, due to hormonal changes induced
by delivery and/or stress experienced due to child rearing. Hence, we asked the mothers to complete the ATQ
short form twice, both at late pregnancy (mean = 27.2 days prior to delivery) and at about 1 month (mean = 32.9
days) after delivery. Reliability estimates (Cronbach’s alpha) of factor scales were from .64 (Extraversion/
Surgency) to .82 (Negative Affectivity) before delivery, and from .63 (Extraversion/Surgency) to .85 (Negative
Affectivity) after delivery. The relationships of all ATQ factor scale scores between before and after delivery
were very high (mean $r = .80$). Thus, we created more robust composite scale scores by calculating an average
of each scale score of the ATQ before and after delivery, and we used these scores in later analysis.

At about 1 month after delivery, mothers also completed the Zung Self-Rating Depression Scale (SDS;
Zung, 1965) which consists of 20 items. The original 4-point scale of the SDS items was modified into a
seven-point scale to match the rating scale of the ATQ, because the SDS items were inserted into the ATQ
questionnaire items. The depression scale score was calculated similarly to the ATQ scale scores noted above.
The reliability estimate of the Depression Scale was sufficiently high (.86).

When a mother’s infant reached 10 months old, we administered the JCFRI Child Rearing Support
Questionnaire which consists of 75 items to be rated on a four-point scale (Japan Child and Family Research
Institute Aiiku Child and Family Counseling and Guidance Clinic, Imperial Gift Foundation Boshi-Aiiku-Kai, 2003). This questionnaire measures maternal difficulties with child rearing, husband support, and so on. We utilized the first two measures in this study.

**Infant measures**

Infant temperament was assessed at 3, 10, and 16 months of age using the Japanese IBQ-R (Nakagawa & Sukigara, 2005). The IBQ-R consists of 191 items and measures 14 scales: Activity Level, Distress to Limitation, Fear, Duration of Orienting, Smiling and Laughter, High Intensity Pleasure (High Pleasure), Low Intensity Pleasure (Low Pleasure), Soothability, Falling Reactivity/Rate of Recovery from Distress (Falling Reactivity), Cuddliness, Perceptual Sensitivity, Sadness, Approach, and Vocal Reactivity (see Appendix B). Mothers were asked to rate how often their infants engaged in the various behaviors described in each item during the last week, from 1 (never), 4 (about half the time), to 7 (always). When the mothers did not see their infants in the situation described in a given item during the last week, they were asked to check “Does Not Apply (X).”

Although the IBQ-R has been designed to measure temperament in infants, three mothers at 3 months and one mother at 10 months were excluded from the analysis because they had many “X”s or missing values (more than 30% of the total items). Six items had a large number of “X”s or non-respondents, for at least 50% of infants of 3 months old, and were eliminated from each scale for 10 and 16 months as well as 3 months to enable comparison of the scale scores with each other, although there were no such items for 10 and 16 months.

Scale scores were computed similarly to the ATQ scale scores noted above. Reliability estimates of the IBQ-R scale were from .65 to .87 (mean = .78) for the 3-month-olds, from .43 to .88 (mean = .73) for the 10-month-olds, and from .67 to .91 (mean = .76) for the 16-month-olds. Three factor scale scores were computed based on the result by Putnam et al. (2001); Positive Affectivity/Surgency (Positive Affectivity), Negative Affectivity, and Regulatory Capacity/Orienting (Regulatory Capacity; see Appendix B). The reliability estimates of Positive Affectivity, Negative Affectivity, and Regulatory Capacity were .70, .71, and .66 for the 3-month-olds, .72, .63, and .59 for the 10-month-olds, and .76, .73, and .38 for the 16-month-olds.

**RESULTS**

**Stability and changes in infant temperament from 3 to 16 months**

Table 1 shows the Pearson correlations between the same scales and factor scales of the IBQ-R measured at 3, 10, and 16 months. The scale scores were more stable between 10 and 16 months than between 3 and 10 months, and most of the scale scores showed significant stability from 10 to 16 months with the exception of Duration of Orienting. The means of the 14 scales’ rs were .35 from 3 to 10 months, .54 from 10 to 16 months, and .29 from 3 to 16 months. The means of the three factor scales’ rs were .55 from 3 to 10 months, .68 from 10 to 16 months, and .42 from 3 to 16 months. The following scales and factor scales exhibited significant correlation throughout the three times of measurement: Smiling and Laughter, Low Pleasure, Falling Reactivity, Perceptual Sensitivity, Vocal Reactivity scales, and all three factor scales.

In order to explore the developmental change in infant temperament, we conducted separate ANOVAs for each temperament scale and factor scale score, including gender as the between-subjects factor and age as the within-subjects factor. We found significant interactions between age and gender only for Distress to Limitation, $F(2, 90) = 5.89, p < .01$: The girls showed significantly higher scores only at 10 months. There was no significant main effect of gender for any scale with the exception of cuddliness: The girls had a significantly higher score than the boys, $F(1, 45) = 4.81, p < .05$. Except for Smiling
and Laughter, Low Pleasure, Soothability scales, and Regulatory Capacity, age effects were significant for all scales and factor scales: most of these scale scores increased with age, but for the Duration of Orienting, Cuddliness, and Sadness scale, the score decreased with age, and Activity Level at 10 months showed the highest scale scores among three different months of age (Table 2).

**Correlations between maternal measures and the IBQ-R factor scales**

Because both the ATQ and IBQ-R include so many scales, we examined the relationship between the ATQ and IBQ-R for only factor scales thereafter. Correlations between maternal measures and IBQ-R factor scale scores at three different months of age are exhibited in Table 3. Whereas no significant correlations were observed between maternal depression and the IBQ-R factor scales at any age, there were significant correlations between the ATQ and the IBQ-R factor scales; between the Negative Affectivity factor scale of the ATQ and the IBQ-R at 3 months; between the Orienting Sensitivity of

<table>
<thead>
<tr>
<th>IBQ-R scale</th>
<th>3 and 10 (N = 48)</th>
<th>3 and 16 (N = 49)</th>
<th>10 and 16 (N = 49)</th>
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<tr>
<td>Activity Level</td>
<td>.24</td>
<td>.15</td>
<td>.64***</td>
</tr>
<tr>
<td>Distress to Limitation</td>
<td>.22</td>
<td>.19</td>
<td>.58***</td>
</tr>
<tr>
<td>Fear</td>
<td>.26</td>
<td>.24</td>
<td>.63***</td>
</tr>
<tr>
<td>Duration of Orienting</td>
<td>.34*</td>
<td>.31*</td>
<td>.21</td>
</tr>
<tr>
<td>Smiling and Laughter</td>
<td>.50***</td>
<td>.38**</td>
<td>.70***</td>
</tr>
<tr>
<td>High Pleasure</td>
<td>.26</td>
<td>.36*</td>
<td>.53***</td>
</tr>
<tr>
<td>Low Pleasure</td>
<td>.43**</td>
<td>.35*</td>
<td>.68***</td>
</tr>
<tr>
<td>Soothability</td>
<td>.31*</td>
<td>.02</td>
<td>.32*</td>
</tr>
<tr>
<td>Falling Reactivity</td>
<td>.29*</td>
<td>.35*</td>
<td>.49***</td>
</tr>
<tr>
<td>Cuddliness</td>
<td>.28</td>
<td>.44**</td>
<td>.57***</td>
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<tr>
<td>Perceptual Sensitivity</td>
<td>.54***</td>
<td>.50***</td>
<td>.72***</td>
</tr>
<tr>
<td>Sadness</td>
<td>.45**</td>
<td>.13</td>
<td>.34*</td>
</tr>
<tr>
<td>Approach</td>
<td>.29*</td>
<td>.28</td>
<td>.48**</td>
</tr>
<tr>
<td>Vocal Reactivity</td>
<td>.52***</td>
<td>.40**</td>
<td>.63***</td>
</tr>
<tr>
<td>Positive Affectivity</td>
<td>.58***</td>
<td>.48**</td>
<td>.79***</td>
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<tr>
<td>Negative Affectivity</td>
<td>.54***</td>
<td>.30*</td>
<td>.61***</td>
</tr>
<tr>
<td>Regulatory Capacity</td>
<td>.54***</td>
<td>.48***</td>
<td>.63***</td>
</tr>
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</table>

* p < .05, ** p < .01, *** p < .001.
the ATQ and Regulatory Capacity of the IBQ-R at 10 months; and between the Extraversion/Surgency of the ATQ and both Positive Affectivity and Regulatory Capacity factor scales of the IBQ-R at 16 months.

Parenting difficulties had significant relation with Regulatory Capacity of the IBQ-R at 10 months.

Predicting the factor scale scores of the IBQ-R

In order to examine the influence of the prior infant’s temperament, maternal characteristics, and husband support on development of infant’s temperament, we conducted a hierarchical regression analysis of the IBQ-R factor scales at 10 and 16 months. As can be seen from Table 1, the IBQ-R factor scale scores showed stability from 3 to 16 months. In addition, the Positive Affectivity and Regulatory Capacity factor scales
of the IBQ-R are intercorrelated with each other ($r = .35$ at 3, .53 at 10, and .70 at 16 months). Thus, in order to examine the contribution of other influencing factors such as mother’s temperament to IBQ-R factor scales, we must control for preceding IBQ-R factor scale scores. Therefore, we entered all preceding factor scale scores of the IBQ-R in the first step. In the next step, we entered all ATQ factor scales, maternal depression, parenting difficulties, and husband support. Given the relatively large number of predicting variables for a small sample size, we entered predicting variables using the stepwise method at each steps.

Table 4 gives information for the significant predictor variables that are included in the models. The results of the Negative Affectivity at 10 months and 16 months, and the Positive Affectivity at 16 months were not shown in the Table 4, because there were no significant predictors for these variables except for the same prior factor scales. Whereas the prior Regulatory Capacity of the IBQ-R contributes additional significant variance in

<table>
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<tr>
<th>IBQ-R factor scale</th>
<th>Maternal measures</th>
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<tr>
<td></td>
<td>Negative Affectivity</td>
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<td>3 months</td>
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<td>Positive Affectivity</td>
<td>.01</td>
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<tr>
<td>Negative Affectivity</td>
<td>.30*</td>
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<tr>
<td>Regulatory Capacity</td>
<td>-.13</td>
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<tr>
<td>10 months</td>
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<tr>
<td>Positive Affectivity</td>
<td>.09</td>
</tr>
<tr>
<td>Negative Affectivity</td>
<td>.21</td>
</tr>
<tr>
<td>Regulatory Capacity</td>
<td>-.07</td>
</tr>
<tr>
<td>16 months</td>
<td></td>
</tr>
<tr>
<td>Positive Affectivity</td>
<td>-.08</td>
</tr>
<tr>
<td>Negative Affectivity</td>
<td>.11</td>
</tr>
<tr>
<td>Regulatory Capacity</td>
<td>-.02</td>
</tr>
</tbody>
</table>

* $p < .05$, ** $p < .01$. 
Positive Affectivity at 10 months, prior Positive Affectivity of the IBQ-R added significant variance in Regulatory Capacity at both 10 and 16 months: Infants with higher Positive Affectivity later came to have higher Regulatory Capacity. Moreover, after controlling for the prior Regulatory Capacity and Positive Affectivity of the IBQ-R, the Orienting Sensitivity of the maternal ATQ added a significant 12% of the explained variance in 10-months’ Regulatory Capacity: Mothers with higher scores on Orienting Sensitivity had infants with higher scores on the Regulatory Capacity factor scale than mothers with lower scores on Orienting Sensitivity. Other measures such as maternal depression, parenting difficulties, and husband support did not significantly predict any IBQ-R factor scales.

Type of maternal temperament and the development of infant temperament

To further ascertain the relationship between maternal and infant temperament obtained above, we examined whether or not there were differences in temperamental development among infant groups of mothers with different temperamental characteristics. At first, hierarchical cluster analysis (Ward’s method) was performed on the four ATQ factor scale scores to determine the appropriate number of clusters of mothers. A three-cluster solution was suggested from the dendrogram. Next, in order to explore the distinctive features of these three clusters, we executed separate ANOVAs for each of the ATQ factor scale scores, including clusters as the between-subjects factor. There were significant effects of cluster for all scales: $F(2, 55) = 25.79$, $p < .001$, for Negative Affectivity, $F(2, 55) = 14.68$, $p < .001$, for Effortful Control, $F(2, 55) = 4.18$, $p < .05$, for Extraversion/Surgency, and $F(2, 55) = 21.01$, $p < .001$, for Orienting Sensitivity. The mean scores of clusters on four ATQ factor scores are shown in Fig. 1. The first cluster was
high on Negative Affectivity, Extraversion/Surgency, and Orienting Sensitivity and moderate on Effortful Control; this cluster was labeled High Sensitive. The second cluster was low on Negative Affectivity, moderate on Extraversion/Surgency and Orienting Sensitivity, but high on Effortful Control; this cluster was labeled Emotion Regulation (ER) Competent. The third cluster was high on Negative Affectivity, but low on Effortful Control, Extraversion/Surgency, and Orienting Sensitivity; this cluster was labeled ER Incompetent. The number of mothers in each cluster was 26, 22, and 10.

The three clusters were then used as the between-subjects factor in mixed ANOVAs for each IBQ-R factor scale, in which the within-subjects factor was age in months. There was no interaction effect for age × cluster. Significant main effects of age for Positive Affectivity and Negative Affectivity factor scales of the IBQ-R were obtained, but these results were omitted because they overlapped with the earlier description. A significant effect of the cluster was obtained only for the Regulatory Capacity factor scale, \( F(2, 44) = 4.07, p < .05 \). Consistent with the preceding hierarchical regression analysis, post hoc analysis revealed that there was significant difference between the High Sensitive and the ER Incompetent group, in which children of mothers of the High Sensitive group showed higher scores on the Regulatory Capacity factor scale than those of ER Incompetent mothers (Fig. 2).

**DISCUSSION**

The main goals of this study were (a) to explore the influence of maternal characteristics...
and depression on a child’s temperamental development and (b) to examine developmental change and stability in infant temperament. We have obtained several intriguing results, which of course need replication in a larger Japanese sample before firm conclusions can be drawn.

First, it was maternal temperamental characteristics that influenced the development of infant temperament rather than maternal depression after delivery, difficulties with parenting, and husband support. In considering the linkage between the temperaments of the mother and the child, we primarily presume that there is genetic transmission between them. In that case, it was predicted that there are connections between similar factor scales of mother and infant. It was only for Negative Affectivity at 3 months that a significant relationship was found between the same temperamental factors of mother and infant. Given the evidence showing rater bias, this relationship between temperamental characteristics of mothers and infants might reflect the effect of maternal bias on the perception of her infant’s temperament. As many researchers have shown evidence for significant genetic influence on negative emotion (Emde et al., 1992; Plomin et al., 1993), however, it is likely that the genetic influence on negative emotion wanes as an infant’s age increases. Thus, it seems that the genetic influence of maternal temperament on her infant’s temperament depends on the developmental stage of the infants.

Second, significant relationships between different temperament factors of mother and infant, that is, the relationship between maternal Orienting Sensitivity and an infant’s Regulatory Capacity/Orienting, emerge as the infant develops. Maternal Orienting Sensitivity consists of the Neutral Sensitivity, Affective Sensitivity, and Associative Sensitivity scale. Infant’s Regulatory Capacity/Orienting factor scale doesn’t include

![Fig. 2. Developmental change in the Regulatory Capacity score of the IBQ-R for infants of each cluster of mothers.](image-url)
Perceptual Sensitivity scale, which is a constituent of Extraversion/Surgency. Therefore, the maternal Orienting Sensitivity factor scale is different from the Infant’s Regulatory Capacity/Orienting factor scale. Infants whose mothers had higher Orienting Sensitivity came to exhibit higher Regulatory Capacity/Orienting at 10 months. This result is important in showing that temperamental individual differences thought to derive partly from heredity could actually be affected by environmental factors, especially maternal characteristics that are not supposed to have the same genetic base.

Until now, maternal sensitivity has been shown to influence many aspects of a child’s development, especially on the infant’s attachment relationship with the mother (Ainsworth, Bell, & Stayton, 1971; Belsky, Rovine, & Taylor, 1984; van den Boom, 1994). Recently, it was demonstrated that there are interactions between maternal sensitivity and genetic risk over time (Propper et al., 2008). Maternal sensitivity in these studies, however, refers to one within the context of the interaction between mother and infant: consistent perceptions, accurate interpretations of, and contingent and appropriate responses to her infant’s signals.

Orienting Sensitivity, which we measured by the ATQ, differs slightly from maternal sensitivity in that Orienting Sensitivity includes sensitivity to low-intensity stimuli rather than interpersonal sensitivity. Nevertheless, Orienting Sensitivity of the mother affects the development of the infant’s Regulatory Capacity/Orienting. Moreover, a similar result was obtained when mothers were divided into three groups with different temperamental characteristics. It was ascertained that the development of Regulatory Capacity/Orienting in infants was encouraged when their mothers were highly sensitive. This finding suggests that perceptual sensitivity itself is needed for the regulation of an infant’s negative emotion. In early infancy, emotional regulation is accomplished mainly through a responsive caregiving environment (Kopp, 1989; Sroufe, 1996). A sensitive mother can easily notice her infant’s signs of distress and other affective communications. As a result, the negative emotion of a more sensitive mother’s infant is supposed to be better controlled. Additional research needs to be done to investigate how mothers with high Orienting Sensitivity actually promote regulation of their infant’s negative emotion.

Third, developmental linkage was seen within the factors of infant temperament. The development of Regulatory Capacity/Orienting of infants at both 10 and 16 months was affected by their previous own Positive Affectivity/Surgency; Infants with higher Positive Affectivity/Surgency later came to have higher Regulatory Capacity/Orienting. In contrast, it was revealed that the Regulatory Capacity/Orienting of infants did not affect their own Positive Affectivity/Surgency developmentally except at 10 months. In other words, the developmental associations between Positive Affectivity/Surgency and Regulatory Capacity/Orienting of the infant were asymmetrical. According to Rothbart’s framework of temperament (1989), infants’ self-regulatory process is supposed to modulate positive and negative affective reactions of infants, and vice versa. Our developmental findings seem to support a part of her framework.

How could the Positive Affectivity/Surgency of the infant affect the infant’s Regulatory Capacity/Orienting? We suppose that the Positive Affectivity/Surgency of infants might influence children’s Regulatory Capacity/Orienting by increased opportunities
for mother-infant interactions. As many researchers advocate, emotional regulation in early infancy requires maternal support and could be accomplished in a coordinated exchange between mother and infant (Kopp, 1989; Sroufe, 1996; Stern, 1985). Coordinated infant-mother face-to-face interaction affords the experience of positive affect regulation for the infant (Feldman, 2003). An infant with higher Positive Affectivity/Surgency is much more likely to involve his/her mother in social interaction with him/her by his/her higher positive emotion. Consequently, evolved synchronized and coordinated interaction between them affords opportunities for emotion regulation, which results in his/her improvement of Regulatory Capacity/Orienting. In fact, Feldman, Greenbaum, and Yirmiya (1999) demonstrated the link between face-to-face reciprocity in infancy and the emergence of self-regulatory mechanisms during the toddler years. However, our assumption remains a matter of speculation. It is necessary to observe the actual mother-infant interactions and demonstrate the difference between infants with high and low Positive Affectivity/Surgency in the future.

While we obtained the result that the development of infants’ temperament was affected by both maternal and their own temperamental characteristics, individual differences in infant temperament were ascertained to be developmentally stable, especially after 10 months of age. This result coincided with other researchers’ findings concerning the stability of infant temperament (Rothbart, 1981; Worobey & Blajda, 1989). In spite of this temperamental stability for individual differences, that is, rank order, most of the temperament scale scores showed developmental change. Concerning the directions of these changes, most of them were in agreement with the previously reported results using cross-sectional samples (Gartstein & Rothbart, 2003; Nakagawa & Sukigara, 2005). Additionally, it was found that there were no gender differences for temperament scales before 16 months of age, except a few scales. However, since other researchers have found evidence for gender differences regarding High Pleasure and Fear with both Japanese and American samples (Gartstein & Rothbart, 2003; Nakagawa & Sukigara, 2005), further study is necessary for gender differences in infants.

There are limitations of our study which should be considered when interpreting the results and their implications. First, as noted earlier, our sample was rather small and the results might be sample specific. Our results noted above need to be examined using a larger sample in the future. Second, our research dealt with maternal characteristics only as influencing factors on a child’s development. Supposing a child’s temperament is hereditary, we should also examine the influence of father’s temperament on development of child’s temperament.

Third, maternal depression that has been reported to be linked to a child’s temperament development in other studies did not have an influence in our sample. This result might be due to our sample characteristics which was a non-clinical sample. Moreover, the period of measurement of maternal depression might have affected our result. Although there are studies showing that maternal depression after delivery is connected with a child’s negative emotionality (Bridgett et al., 2009; Pauli-Pott et al., 2004), Huot et al. (2004) demonstrated that maternal depression during pregnancy, but not postpartum, predicted the ratings of negative affect in the offspring. Additionally, the fetal programming hypothesis suggests
that disturbing factors during specific sensitive periods of fetal development exercise organizational effects in a variety of systems (O’Connor, Heron, Golding, Beveridge, & Glover, 2002). Thus, exploring the influence of maternal depression during pregnancy on the infant’s development of temperament is required.

Finally, as always pointed out in questionnaire research, due to the possibility of parental bias, it is necessary to confirm our results using objective behavior observation measures, especially concerning the effects of maternal and infant temperament on the development of infant temperament.

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Hoshi, N., & Kusanagi, E. 2012. An examination of psychometric properties of ATQ. *Sapporo Otani University, Sapporo Otani Junior College Bulletin, 42*, 57–63. (In Japanese)


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**Appendix A**

Scale Definitions and Sample Items from the Adult Temperament Questionnaire Short Form

<table>
<thead>
<tr>
<th>Negative Affectivity</th>
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<tbody>
<tr>
<td><strong>Fear</strong></td>
<td>Negative affect related to anticipation of distress. “I become easily frightened.”</td>
</tr>
<tr>
<td><strong>Sadness</strong></td>
<td>Negative affect and lowered mood and energy related to exposure to suffering, disappointment, and object loss. “I rarely feel sad after saying goodbye to friends or relatives.” (reverse)</td>
</tr>
<tr>
<td><strong>Discomfort</strong></td>
<td>Negative affect related to sensory qualities of stimulation, including intensity, rate or complexity of visual, auditory, smell/taste, and tactile stimulation. “I find loud noises to be very irritating.”</td>
</tr>
<tr>
<td><strong>Frustration</strong></td>
<td>Negative affect related to interruption of ongoing tasks or goal blocking. “I rarely become annoyed when I have to wait in a slow moving line.” (reverse)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Extraversion/Surgency</th>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Sociability</strong></td>
<td>Enjoyment derived from social interaction and being in the presence of others. “I usually like to talk a lot.”</td>
</tr>
<tr>
<td><strong>Positive Affect</strong></td>
<td>Latency, threshold, intensity, duration, and frequency of experiencing pleasure. “Sometimes minor events cause me to feel intense happiness.”</td>
</tr>
</tbody>
</table>
High Intensity Pleasure
Pleasure related to situations involving high stimulus intensity, rate, complexity, novelty, and incongruity.
“When listening to music, I usually like turn up the volume more than other people.”

Effortful Control
Attentional Control
Capacity to focus attention as well as to shift attention when desired.
“It’s often hard for me to alternate between two different tasks.” (reverse)

Inhibitory Control
Capacity to suppress inappropriate approach behavior.
“Even when I feel energized, I can usually sit still without much trouble if it’s necessary.”

Activation Control
Capacity to perform an action when there is a strong tendency to avoid it.
“I am often late for appointments.” (reverse)

Orienting Sensitivity
Neutral Perceptual Sensitivity
Detection of slight, low intensity stimuli from both within the body and the external environment.
“Barely noticeable visual details rarely catch my attention.” (reverse)

Affective Perceptual Sensitivity
Spontaneous emotionally valenced, conscious cognition associated with low intensity stimuli.
“When I am listening to music, I am usually aware of subtle emotional tones.”

Associative Sensitivity
Spontaneous cognitive content that is not related to standard associations with the environment.
“Without applying effort creative ideas sometimes present themselves to me.”

Appendix B

Scale Definitions and Sample Items from the Infant Behavior Questionnaire-Revised

Negative Affectivity

Fear
The baby’s startle or distress to sudden changes in stimulation, novel physical objects or social stimuli; inhibited approach to novelty.
“How often during the last week did the baby startle to a sudden or loud noise?”

Sadness
General low mood; lowered mood and activity specifically related to personal suffering, physical state, object loss, or inability to perform a desired action.
“Did the baby seem sad when caregiver is gone for an unusually long period of time?”

Distress to Limitation
Baby’s fussing, crying or showing distress while a) in a confining place or position; b) involved in caretaking activities; c) unable to perform a desired action.
“How often during the last week did the baby protest being placed in a confining place (infant seat, play pen, car seat, etc.)?”
### Falling Reactivity/Rate of Recovery from Distress
Rate of recovery from peak distress, excitement, or general arousal; ease of falling asleep.
“When going to bed at night, how often does your baby fall asleep within 10 minutes?”

### Positive Affectivity/Surgency

<table>
<thead>
<tr>
<th>Description</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td><strong>Activity Level</strong></td>
<td>Baby’s gross motor activity, including movement of arms and legs, squirming, and locomotor activity. “During feeding, how often did the baby lie or sit quietly?”</td>
</tr>
<tr>
<td><strong>Perceptual Sensitivity</strong></td>
<td>Amount of detection of slight, low intensity stimuli from the external environment. “During feeding, how often did your baby notice lumpy texture in food (e.g., oatmeal)”</td>
</tr>
<tr>
<td><strong>High Intensity Pleasure</strong></td>
<td>Amount of pleasure or enjoyment related to high stimulus intensity, rate, complexity, novelty, and incongruity. “How often during the last week did the baby smile or laugh when tickled?”</td>
</tr>
<tr>
<td><strong>Smiling and Laughter</strong></td>
<td>Smiling or laughter from the child in general caretaking and play situations. “When put into the bath water, how often did the baby smile?”</td>
</tr>
<tr>
<td><strong>Approach</strong></td>
<td>Rapid approach, excitement, and positive anticipation of pleasurable activities. “When your baby saw a toy s/he wanted, how often did s/he get very excited about getting it?”</td>
</tr>
<tr>
<td><strong>Vocal Reactivity</strong></td>
<td>Amount of vocalization exhibited by the baby in daily activities. “How often did your baby make talking sounds while waiting in a high chair for food?”</td>
</tr>
</tbody>
</table>

### Regulatory Capacity/Orienting

<table>
<thead>
<tr>
<th>Description</th>
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<tbody>
<tr>
<td><strong>Duration of Orienting</strong></td>
<td>The baby’s attention to and/or interaction with a single object for extended periods of time. “How often during the last week did the baby look at pictures in books and/ or magazines for 2-5 minutes at a time?”</td>
</tr>
<tr>
<td><strong>Low Intensity Pleasure</strong></td>
<td>Amount of pleasure or enjoyment related to low stimulus intensity, rate, complexity, novelty, and incongruity. “How often during the last week did the baby enjoy being sung to?”</td>
</tr>
<tr>
<td><strong>Soothability</strong></td>
<td>Baby’s reduction of fussing, crying, or distress when soothing techniques are used by the caretaker. “When rocking your baby, how often did s/he soothe immediately?”</td>
</tr>
<tr>
<td><strong>Cuddliness</strong></td>
<td>The baby’s expression of enjoyment and molding of the body to being held by a caregiver. “When being held, how often did the baby pull away or kick?” (reverse)</td>
</tr>
</tbody>
</table>