

## Sweet babies: chocolate consumption during pregnancy and infant temperament at six months

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### Abstract

*Background:* Chocolate contains several biologically active components potentially having behavioral and psychological consequences. *Aims:* We tested whether chocolate consumption and stress experiences during pregnancy predict mother-rated infant temperament at 6 months. *Design and subjects:* Prenatal frequency of chocolate consumption and intensity of psychological stress experience of the mothers, and temperament characteristics of the infants 6 months postpartum were evaluated in 305 consecutive, healthy mother–infant dyads. *Results:* Mothers who reported daily consumption of chocolate rated more positively the temperament of their infants at 6 months. Maternal prenatal stress predicted more negatively tuned ratings of the infant temperament, particularly among those who reported never/seldom chocolate consumption. However, this effect was not observed among the mothers reporting weekly or daily chocolate consumption. *Conclusions:* In addition to producing subjective feelings of psychological well being, chocolate may have effects at multiple environmental and psychological levels.

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### 1. Introduction

Chocolate contains several biologically active components (methylxanthines, biogenic amines, and cannabinoidlike fatty acids), all of which potentially have behavioral and

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psychological consequences [1–7]. Yet, relatively few studies have addressed possible relationships between chocolate consumption and behavioral and psychological measures [8–11].

Previously published data in the current sample of mothers showed that chocolate consumption during pregnancy was higher among those who felt themselves most stressed [12]. Recent data suggest that maternal prenatal stress and placental hormones may exert significant influences on the fetal central and autonomic nervous system processes [13]. These influences may persist into the postnatal period and are reflected in the infant characteristic temperament [13]. Therefore, we examined whether chocolate consumption during pregnancy would predict mother-rated infant temperament measured at 6 months. We also tested whether the mother's chocolate consumption would modulate potential relationships between mother's prenatal psychological stress experiences and infant temperament.

## 2. Methods

### 2.1. Participants

Three-hundred and five mother–infant dyads, derived from an initial sample of 1049 consecutive, healthy mother–infant dyads, participated in the study [14]. In the initial sample, 8.7% of the infants were born by caesarian section. Recruitment took place in a large maternity hospital, with approximately 4500 births per year, in the city of Helsinki, Finland. After the delivery, while still on the maternity ward, the first 500 mothers were invited to participate in a psychological survey on child development follow-up. The local Institutional Review Board (City of Helsinki) approved this project, and participating parents gave informed consent. The mothers in the current study were younger ( $M=29.1$  vs.  $29.9$ ,  $p<0.01$ ) and reported less prenatal stress ( $M=34.5$  vs.  $38.2$ ,  $p<0.02$ ) than the mothers in the initial sample. No significant differences were observed in the maternal chocolate consumption, body mass index, mode of delivery, gestational age, or birth weight of the infant between the current and initial samples.

### 2.2. Measures

#### 2.2.1. Prenatal chocolate consumption and psychological stress experience

After the delivery, while still in the maternity ward, mothers were asked to report the frequency of their prenatal chocolate consumption using a scale from never, seldom, weekly to daily, and rate their level of prenatal psychological stress experience using a visual analogue ranging from 0 mm (no stress) to 100 mm (maximal stress).

#### 2.2.2. Infant temperament

Six months (S.D. = 1.3, range: 4 to 9 months) after the delivery, the mothers rated the infant temperament using a standardized Infant Behavior Questionnaire (IBQ) [15] The IBQ yields individual character trait scores rated as infant behaviors during the past 2 weeks that reflect the infant's level of activity, proneness to smiling and laughter, fear (i.e.,

distress and extended latency to approach intense or novel stimuli), distress to limitation, soothability, and duration of orienting. In addition, the IBQ yields cluster trait scores of negative and positive emotional reactivity derived by summing (item-weighted) the fear and the distress to limitations, and the activity and the smiling and laughter scores, respectively [16].

### 2.3. Statistical analyses

Univariate one- and two-way analyses of variance (ANOVAs) were computed to test associations between maternal prenatal chocolate consumption (never/seldom, weekly, daily) and mother-rated infant temperament at 6 months, and whether chocolate consumption would modulate potential relationships between mother's prenatal psychological stress experiences (tertile split) and infant temperament. Follow-up analyses were computed for significant effects using *t* tests for pair-wise comparisons and polynomial contrasts to test the effect linearity.

## 3. Results

Three hundred and five mothers and their infants participated in the current study. Never/seldom, weekly, and daily consumption of chocolate during pregnancy was reported by 94 (of these, four reported never consumption), 201, and 10 mothers, respectively. Mean reported stress score was 34.5, (S.D. = 25.9), and tertile cutpoints were 8, 27, and 69. Table 1 shows that the mother's chocolate consumption, grouped as never/seldom, weekly, and daily consumption, significantly predicted the infant's positive reactivity [ $F(2,302)=4.43$ ,  $p<0.01$ ] and activity [ $F(2,303)=4.80$ ,  $p<0.01$ ]. The ratings of the

Table 1  
Infant's temperament at 6 months according to mother's chocolate consumption during pregnancy

Infant's temperament at 6 months	Mother's chocolate consumption during pregnancy			ANOVA	
	Never/seldom	Weekly	Daily	<i>F</i>	<i>p</i>
<i>Cluster traits</i>					
Positive reactivity	9.59(1.30)	9.69(1.34)	10.90(1.25)	4.43	0.01*
Negative reactivity	5.22(1.15)	5.28(1.21)	5.34(1.18)	0.26	0.77
<i>Individual character traits</i>					
Activity	4.39(0.77)	4.55(0.77)	5.16(0.71)	4.80	0.01*
Smiling and laughter	5.18(0.81)	5.24(0.86)	5.71(0.77)	1.82	0.16*
Fear	2.28(0.70)	2.22(0.63)	2.11(0.64)	0.43	0.72
Distress to limitations	2.95(0.71)	3.06(0.78)	3.28(0.80)	1.68	0.19
Duration of orienting	4.01(1.07)	3.81(1.15)	4.26(1.18)	1.74	0.18
Soothability	4.82(1.02)	5.06(1.07)	5.14(1.08)	1.54	0.22

Values are mean (S.D.). \*Trend analysis indicates a significantly linearly increasing trend for positive reactivity ( $p<0.003$ ), activity ( $p<0.002$ ), and smiling and laughter ( $p<0.057$ ).

infant as more positively reactive and active were greater for daily chocolate consumers vs. weekly consumers (for positive reactivity:  $t=2.7$ ,  $p<0.007$ ; for activity:  $t=2.8$ ,  $p<0.005$ ;  $p<0.02$  is significant at Bonferroni level;  $p<0.05$  is significant for all pairwise comparisons) and between daily consumers and never/seldom consumers (for positive reactivity:  $t=3.0$ ,  $p<0.003$ ; for activity:  $t=3.0$ ,  $p<0.003$ ). Weekly and never/seldom users did not significantly differ from each other ( $t<0.64$ ,  $p>0.52$ ). There were significantly increasing linear trends of positive reactivity ( $p<0.003$ ) and of activity ( $p<0.002$ ) from never/seldom to weekly to daily chocolate consumption.

The mother's prenatal stress experience significantly predicted the infant's fear responses [ $F(2,303)=3.18$ ,  $p<0.04$ ]. Mothers who experienced the most stress rated their infants more fearful [ $M(S.D.)=2.32(0.73)$ ] than the least stressed mothers [ $M(S.D.)=2.27(0.58)$ ;  $t=2.3$ ,  $p<0.02$ ] or moderately stressed mothers [ $M(S.D.)=2.10(0.63)$ ;  $t=2.0$ ,  $p<0.05$ ]. Ratings of the most and the moderately stressed mothers were not significantly different ( $t=0.58$ ,  $p=0.56$ ). There was a significantly increasing linear trend in fear from the least to the moderate and the most experienced stress ( $p<0.017$ ).

The relationships between prenatal stress and mother-rated infant temperament seemed to be modulated by the maternal chocolate consumption [ $F(2,300)=3.0$ ,  $p<0.05$  for "chocolate consumption  $\times$  experienced stress" on fear]. Among mothers reporting never/seldom chocolate consumption, those who had experienced moderate or most stress during pregnancy rated their infants as significantly more fearful in temperament than the least stressed mothers [moderately vs. least stressed:  $t=2.8$ ,  $p<0.007$ ; most vs. least stressed:  $t=3.0$ ,  $p<0.004$ ;  $F(2,92)=5.8$ ,  $p<0.004$ ]. The trend in fear from the least to the moderate to the most experienced stress was significantly increasingly linear for the never/seldom

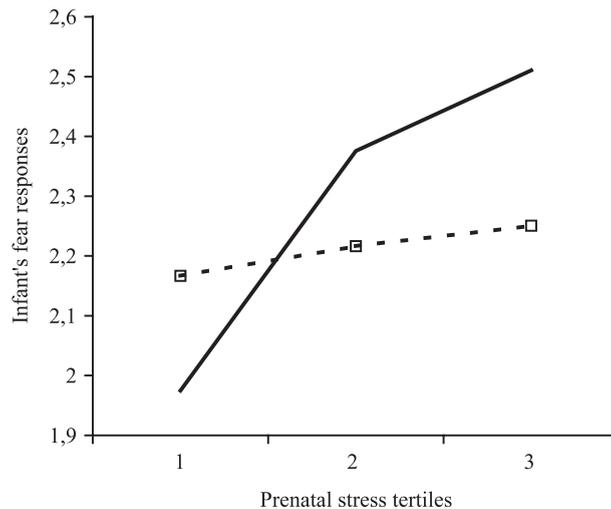


Fig. 1. Mean values of infant's fear responses at 6 months according to mother's stress experiences (tertile split) and chocolate consumption during pregnancy. Dashed line refers to weekly/daily chocolate consumption, and continuous line refers to never/seldom chocolate consumption.

chocolate consumers ( $p < 0.002$ ). Fig. 1 shows, however, that when the mother reported consuming chocolate weekly/daily, her prenatal stress experience had no significant effects on the infant's fear responses [ $F(2,208) = 0.32$ ,  $p = 0.73$ ].

#### 4. Discussion

Maternal prenatal consumption of chocolate was associated with the infant temperament in this study. Mothers who reported consuming chocolate daily rated their infants at 6 months as more positively reactive and active. An intriguing finding was that maternal chocolate consumption may provide favorable effects for the infants of the most stressed mothers. While prenatal stress predicted more negatively tuned maternal ratings of the infant temperament, particularly in the group who reported never or seldom chocolate consumption, the effect of maternal stress on infant temperament was not observed in the group of mothers reporting weekly to daily chocolate consumption.

The biologically active components of chocolate, methylxanthines, biogenic amines, and cannabinoidlike fatty acids [1–7], may play a mediating role in the associations between chocolate consumption and infant temperament. Caffeine and theobromine may act as stimulants to elevate activity. Phenylethylamine affects the brain's "mood centers" and presumably play a role in inducing the emotion of falling in love. The endogenous cannabinoid system may also be involved as anandamide has been identified in cacao [3–5]; cannabinoid drugs are known to heighten sensitivity and produce euphoria [17]. The mediating mechanisms are not mutually exclusive; for instance, elevated anandamide levels may cooperate with the methylxanthines to produce transient feelings of well being.

There are alternative explanations for our current findings. Firstly, continuous phenylethylamine/anandamide exposure during pregnancy may have endogenously affected the neurodevelopment of the infant, promoting positive reactivity and activity characteristics of the temperament. Secondly, prenatal exposure to these agents may have also buffered the endogenously mediated effects of maternal prenatal stress on the infant's postnatal temperament.

Finally, it is possible that the infant's active and positively reactive temperament is a result of positive mother–infant interaction during the early development. The positive interaction may result from actual behavioral characteristics of the infant at the neonatal period, or from chocolate-induced heightened maternal sensitivity and positive mood during the postnatal period.

There are several possible limitations in our study. We only know the reported frequency of chocolate consumption during pregnancy, not the actual quantity or quality (dark, milk, bars) of the chocolate consumed. Neither do we know whether the women continued the chocolate consumption after delivery—although common knowledge suggests that this is likely. Furthermore, as all enjoyable food may stimulate endorphin release in the brain, a question may be raised whether the current findings reflect effects from consumption of any candy or food [18]. This seems unlikely, as mother's licorice consumption during pregnancy was not associated with the infant temperament in this study ( $p > 0.26$ ; data not shown). We cannot rule out that the results may reflect a common denominator that underlies both chocolate consumption and infant temperament. Although

it has been suggested that a chocolitist personality may exist, we did not find associations between mothers' chocolate consumption and the Big Five personality traits [19], suggesting that personality does not confound these associations. Finally, although the significant findings centered around two character traits of temperament, namely, positive and negative emotional reactivity, it cannot be overlooked that multiple testing may have led to a spurious result.

Despite the limitations, our results show that chocolate may have positive and even salubrious effects. Overall, there is lack of studies linking nutrition and temperament. Yet, there is a sound, validated biological rationale for expecting an influence of nutritional factors on individual variability in human temperament [20]. This applies also for chocolate. In the light of previous study findings showing that early appearing temperamental differences have pervasive developmental influences on personality structure, psychopathology, and crime in adulthood [21], the current findings clearly deserve further examination.

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