

Infant temperament: implications for later sleep and eating/feeding

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Objective: A study was conducted to investigate links between infant temperament and eating/feeding, as well as sleep, in the toddler period. **Background:** Prior studies suggest there may be important connections between temperament and these health-related areas of functioning. However, existing research has been rather limited, generally cross-sectional in nature, with an emphasis on challenging aspects of temperament. As a result, positive emotionality and regulatory capacity, as well as more fine-grained domains of temperament, have been largely neglected. **Method:** Mothers who participated in an infant temperament evaluation were invited to take part in the follow-up study addressing sleep and eating/feeding for toddlers, completing questionnaires concerning these areas of functioning ($N = 27$). The Brief Infant Sleep Questionnaire (BISQ) and the Infant Feeding Practices Questionnaire (IFQ) were utilised to measure sleep and eating/feeding difficulties, respectively, whereas the Infant Behavior Questionnaire-Revised (IBQ-R) provided indicators of temperament. **Results:** Greater infant Vocal Reactivity translated into increased concerns regarding toddler under-eating, whereas Smiling and Laughter were linked with more positive mealtime interactions. Vocal Reactivity, Smiling and Laughter, and High Intensity Pleasure together contributed to Using Food to Calm Fussiness. **Conclusions:** Fine-grained temperament distinctions appear as important in examining links with eating/feeding and sleep. Implications for understanding child health-related variables in the context of infant temperament are discussed.

Keywords: temperament; sleep; eating/feeding

Introduction

Feeding/eating and sleeping domains of infant functioning are important factors in infant growth and development, and are critical for a multitude of other vital outcomes (Chatoor & Ganiban, 2004; Goodlin-Jones & Anders, 2004). A variety of biological and environmental variables influence feeding/eating and sleeping during early childhood, and infant temperament has emerged as an important contributing factor (e.g. Faith & Hittner, 2010; Kelmanson, 2004).

According to Rothbart and Derryberry (1981), temperament represents constitutionally based individual differences in self-regulation and reactivity, influenced by heredity, maturation, and experience. Structurally, this psychobiological model of temperament emphasises fine-grained, conceptually distinctive, dimensions of

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temperament, which have been shown to form three broader overarching factors of Surgency/Extraversion, Negative Emotionality and Regulatory Capacity. Considering the fine-grained domains had been deemed important in gaining a more precise understanding of temperament and related factors (Rothbart & Bates, 2006), and these narrow-band indicators were shown to differentially predict significant behavioural outcomes. For example, fear and anger have been differentially related to internalising and externalising behaviour problems, indicating the importance of distinguishing among Negative Emotionality components (Gartstein, Putnam, & Rothbart, 2012; Lengua, 2006); however, links with childhood health-related variables have not been widely considered. Thus, the present study extends the existing research by examining links between fine-grained domains of infant temperament and two health outcomes of primary importance in early childhood: sleep and eating/feeding.

Prior studies linking temperament to eating/feeding and sleeping in childhood have largely relied on the construct of difficult temperament, finding associations between temperament-related challenges, eating and sleeping problems. Temperament ratings of fussy-difficult were associated with sleeping problems (more frequent night wakings and difficulties settling down for sleep) at 1 year of age, and persistent sleep problems at 2 years of age (Morrell & Steele, 2003). Kelmanson (2004) reported that infants rated as more negative in their emotional expressions were more likely to have problems sleeping throughout the night, and needed parental interaction more frequently before falling back asleep.

Infants described as presenting with more challenging temperament attributes are also more likely to have difficulties with feeding. Infants with feeding disorders were more frequently rated as having a difficult temperament, with their caregivers describing these infants as fussy and difficult to soothe (Bates, Freeland, & Lounsbury, 1979; Feldman, Keren, Gross-Rozval, & Tyano, 2004). In a study of infants in Barbados, difficult temperament was associated with feeding difficulties and greater parental involvement during feeding (Galler, Harrison, Ramsey, Butler, & Forde, 2004). Higher parental ratings of distress to limitations at 12 weeks of age were related to greater body fat percentage at 24–32 months (Wells et al., 1997).

How can we understand these links between temperament and problems with eating/feeding and sleep in early childhood? Two pathways, one direct and one indirect, are likely responsible for the observed associations. The latter involves parenting/parenting–child interactions, because feeding and sleeping activities require substantial parental intervention in the first years of life. Conceptually, the Thomas and Chess (1977) goodness-of-fit model may explain how children with certain temperament attributes evoke less-effective parental responses, which in turn lead to poor fit and difficulties in these important areas of functioning. Direct connections may also be possible, with researchers suggesting, for example, that temperament may ‘modulate sleep/wake regulation’ (Scher, Tirosh, & Lavie, 1998). The infant’s ability to self-soothe when first falling asleep and following night-time wakings has been described as essential for the development of a healthy sleep pattern (Burnham, Goodlin-Jones, Gaylor, & Anders, 2002). With respect to eating/feeding, Vollrath, Tonstad, Rothbart, and Hampson (2011) noted that appetite regulation and ‘internalising’ traits (i.e. negative emotionality, fear and sadness in particular) may have a common genetic basis in sensory sensitivity, likely implicated in feeding styles leading to obesity-related concerns. That is, more sensitive infants tend to engage in more vigorous eating, demonstrating a higher sucking rate

(Llewellyn, van Jaarsveld, Johnson, Carnell, & Wardle, 2010), which if stable, could lead to concerns with overeating and obesity. Vollrath et al. (2011) also proposed that more surgent children likely have an increased caloric need, due to the considerable energy expenditure that results from these emotional/behavioural tendencies, leading to increased feeding and/or feeding of high-calorie foods. It is also possible that surgent/extraverted infants, by the virtue of being more approach-oriented, are more open to new food experiences, which is particularly important to positive and effective mealtime exchanges in early childhood, as new foods are continuously introduced. That is, a child more interested in approaching new objects, including foods, would be easier to engage in trying these in the context of family meals, making mealtimes less stressful (e.g. not resulting in individualised dishes, etc.) and decreasing the likelihood of parental concerns with eating/feeding. Feeding and mealtime interactions are also likely to be more positive and effective for children who exhibit high levels of regulation-related traits, in so far as greater capacity to modulate emotional reactivity results in more responsive parent-child interactions overall (e.g. Morelen & Suveg, 2012).

As evident from the literature reviewed above, a number of studies linking temperament and eating and sleeping problems have focused on difficultness, emphasising the contribution of infant negative emotionality. However, research addressing Orienting/Regulation and Surgency/Extraversion and their fine-grained components has been scarce, with a notable exception (Burton et al., 2011). Burton et al. (2011) explored associations between Surgency/Extraversion and weight gain at 3, 6 and 12 months of age, reporting that higher scores on Surgency/Extraversion predicted weight gain at 3, but not at 6 and 12 months of age. These findings suggest that although positive affectivity and approach may facilitate feeding/eating early in infancy, this function does not remain constant over the first year of life. It should be noted that the Burton et al. (2011) study examined the Surgency/Extraversion at the overarching factor level only, which may have obscured meaningful relationships with the fine-grained dimensions. As fine-grained distinctions have been demonstrated to be important with respect to other areas of child functioning, these should be considered in the context of eating/feeding, as well as sleep problems. Because of the noted gap in research, the present study was designed to address Surgency/Extraversion and Orienting/Regulation, focusing on their respective fine-grained dimensions.

The primary goal of this work was to examine the extent to which temperament ratings obtained in infancy would predict aspects of eating/feeding and sleep between 2 and 3 years of age. Prior research has largely focused on measuring temperament and feeding/sleeping behaviour concurrently, and the present study was intended to examine the utility of infant temperament attributes as predictors of later eating/feeding and sleep functioning. We anticipated relationships between regulation-related domains and sleeping/feeding, as these dimensions in part overlap with the difficult temperament construct. Thus, it was hypothesised that higher levels of characteristics related to regulatory capacity would be protective with respect to eating/feeding and sleep outcomes, leading to fewer parent-reported difficulties. Associations with the fine-grained indicators of Extraversion/Surgency were also examined. As aspects of positive emotionality were largely neglected in prior research, a-priori predictions could not be readily formulated for these attributes. In addition, we measured temperament domains associated with Negative Emotionality, although these do not constitute the primary focus of the present

study. Nonetheless, significant associations between the components of Negative Emotionality and our health-related outcomes were anticipated, given prior findings concerning difficult temperament.

Method

Participants

A sample of mothers of typically developing children in the present study ($N = 27$) represents a portion of a larger group recruited from the community when their infants were 4 months of age (see Table 1 for demographic information). These families had taken part in a larger study ($N = 134$), providing information about temperament development, attachment security and behaviour problems, and this sample has been described elsewhere (e.g. Gartstein et al., 2010). Mothers were asked to complete the Infant Behavior Questionnaire-Revised (IBQ-R), a temperament assessment tool, when their children were 12 months of age, along with a demographic questionnaire. A subsample was selected for the current pilot study, based on the anticipated age of the child at time of the follow-up contact. Thirty-four participants were re-contacted regarding participation in this study when their children were between 24 and 36 months of age, 30 of whom agreed to participate (2 families declined due to time constraints and 2 were never reached). This subsample was compared to the remainder of the overall sample ($n = 104$), not approached regarding participation in the pilot project concerning eating/feeding and sleeping. A total of 22 analyses were performed in the context of comparing responders and non-responders (those not approached regarding participation; $n = 104$), with 2 producing statistically significant results. Specifically, participating mothers reported higher incomes ($t = -2.12$; $p < .05$) and lower levels of Smiling and Laughter for their infants ($t = 2.16$; $p < .05$). Of these 30 participants, 3 children did not have complete IBQ-R data from the 12-month assessment and thus were not included in the analyses. Mean age of the children ($N = 27$) at the time of the follow-up addressing eating/feeding and sleeping was 30 months ($M = 30.0$, $SD = 5.64$). Mothers were asked to complete two questionnaires via a telephone interview for the purposes of the longitudinal follow-up: the Brief Infant Sleep Questionnaire (BISQ; Sadeh, 2004) and the Infant Feeding Practices Questionnaire (IFQ; Baughcum et al., 2001; Sadeh, 2004).

Measures

The *IBQ-R* (Gartstein & Rothbart, 2003) is a 191-item parent-report questionnaire that includes 14 fine-grained temperament dimensions that have been cluster into three overarching factors: Surgency/Extraversion: Activity Level, Smiling and Laughter, Vocal Reactivity, Approach, High Intensity Pleasure and Perceptual Sensitivity; Negative Emotionality: Distress to Limitations, Fear, Sadness and Falling Reactivity (loading negatively); and Orienting /Regulation: Duration of Orienting, Soothability, Cuddliness/Affiliation and Low Intensity Pleasure. Individual items are rated on a 0–7 Likert scale, reflecting the frequency of occurrence of the different manifestations of temperament in the past week (two weeks for less-frequent events). Satisfactory reliability and validity of the *IBQ-R* have been demonstrated (Gartstein & Rothbart, 2003; Parade & Leerkes, 2008). Internal consistency of the 14 *IBQ-R* scales was evaluated in the present sample, with the Cronbach's alphas ranging from .65 to .96 (mean $\alpha = .82$).

Table 1. Descriptive statistics: demographics; independent and dependent variables.

Variable	Mean	Range	Standard deviation	Percentage
Maternal age (Years)	28.67	20–42	5.27	
Ethnicity				
Caucasian				91.9
African American				3.7
Asian				2.9
Hispanic/Latino				1.5
Marital status				
Married				93.1
Divorced/separated				1.6
Single				3.8
Remarried				1.5
Education attainment (years)	15.87	10–20	2.29	
Family income				
\$0–\$7,000				5.2
\$7,001–\$10,000				3.0
\$10,001–\$13,000				5.2
\$13,001–\$16,000				4.5
\$16,001–\$20,000				9.0
\$20,001–\$30,000				10.4
\$30,001–\$50,000				29.9
\$50,001–\$75,000				17.2
Over \$75,000				15.7
Variable	Mean	Range	SD	Percentage
Child's gender				
Males				50.8
Females				49.2
IBQ-R				
Activity Level	4.71	2.80–6.27		.76
Distress to Limitations	4.30	2.88–6.19		.77
Fear	3.07	1.00–5.56		.92
Duration of Orienting	3.74	1.50–6.64		.97
Smiling/Laughter	4.58	2.70–6.60		.90
High Intensity Pleasure	5.88	4.00–7.00		.59
Low Intensity Pleasure	4.79	3.10–6.54		.77
Soothability	3.78	2.17–5.29		.67
Falling Reactivity	5.02	3.54–6.46		.66
Cuddliness	5.15	3.00–6.86		.83
Variable	Mean	Range	SD	Percentage
Perceptual Sensitivity	4.03	1.33–6.67		1.17
Sadness	3.74	1.90–6.07		.92
Approach	5.58	3.42–6.83		.65
Vocal Reactivity	5.01	3.00–6.67		.88
BISQ				
Time Sleeping/Night	10.05	6.00–12.00		1.62
Time Sleeping/Day	2.19	1.00–3.00		.49
Average Wakings/Night	4.6	0.00–21.00		5.66
Time Awake/Night	.35	0.00–1.00		.25
Latency to Fall Asleep/Night	.51	.25–2.00		.34
Sleep Problems	1.30	1.00–3.00		.53
Regular Bedtime	8.45	7.00–10.00		.67

(Continued)

Table 1. (Continued).

Variable	Mean	Range	Standard deviation	Percentage
IFQ				
Concerns/ Under-eating	1.31	0.00–3.50		1.07
Concerns/Hunger	.38	0.00–3.67		.81
Awareness: Hunger/Satiation	3.27	2.00–4.00		.60
Concerns/Over-eating	.48	0.00–2.00		.61
Feeding/Schedule	1.89	1.00–3.50		.56
Using Food to Calm	1.32	0.00–2.50		.86
Fussiness				
Feeding Social Interaction	2.25	.50–4.00		.93

The (*BISQ*) (Sadeh, 2004), a 10-item parent-report measure, was developed to provide a standardized brief sleep screen for clinical and research purposes. The *BISQ* has been found to have satisfactory psychometric properties, including test-retest reliability across multiple assessments, construct and criterion-related validity (Sadeh, 2004). Seven *BISQ* items (Table 1) were examined separately in this study because too few toddlers ($n = 2$) were considered to have clinically significant sleep problems and the intercorrelations (average $r = -0.016$) failed to support further data consolidation.

The *IFQ* was originally designed to determine whether specific maternal feeding practices or attitudes measured at one year of age could predict infant obesity at 2 years (Baughcum et al., 2001). The 28-item *IFQ* was developed to address variables related to feeding, such as parental attitudes, beliefs, and feeding practices, rather than the nutritional aspect of mealtime interactions with infants. The *IFQ* provides indices of seven constructs related to infant feeding: (1) concern about the infant's under-eating and becoming underweight, (2) concern about the infant being hungry, (3) awareness of the infant's hunger and satiety cues, (4) concern about over-eating and becoming overweight, (5) establishing a feeding schedule, (6) using food to calm the infant, and (7) social interactions with the infant during feeding (Baughcum et al., 2001). Questions are answered on a scale of 0–4, with higher ratings indicating greater frequency and/or greater agreement with a given statement.

For the present sample, overall adequate internal consistency for the 7 *IFQ* scales was demonstrated, with Cronbach's alphas ranging from .50 to .83 (mean $\alpha = .63$).

The *Demographic Questionnaire* contained questions about marital status, ethnicity, education, income and occupation. The latter enabled us to compute an index of the Socio-Economic Status (SES) for each participating family: Revised Duncan Sociometric Index (TSEI2; Stevens & Featherman, 1981), a widely used indicator of occupation ranking.

Analyses

Descriptive statistics were computed first (Table 1). Next, correlations between the demographic variables: education, income, SES, child's age, infant temperament, eating/feeding and sleeping scores were examined. None of the coefficients for *IFQ* or the *BISQ* scores reached statistical significance; however, two significant correlations emerged in the context of the 42 correlational analyses involving 14 *IBQ-R*

scales: higher levels of Fear were associated with higher maternal educational attainment ($r = .26$; $p < .05$); higher Perceptual Sensitivity scores were associated with higher SES ratings ($r = .43$; $p < .01$). These two background variables were thus included in the context of multiple regression analyses. The child's age at follow-up was also included as a control variable because of significant correlations with two IFQ factors: Using Food to Calm Fussiness ($r = .37$; $p < .05$), Feeding Social Interaction ($r = -.50$; $p < .01$), and two BISQ items: Time Asleep during the Day ($r = .36$; $p < .05$), Latency to Fall Asleep ($r = .37$; $p < .05$).

Correlations were computed to examine associations between the 14 IBQ-R scales, seven IFQ and seven BISQ scores, employing a weighted Bonferroni-type procedure (Holland & DiPonzio Copenhaver, 1989) to correct for the number of statistical tests. Hierarchical multiple regression analyses were conducted next to determine whether the IBQ-R scale scores reflecting Surgency/Extraversion and Orienting/Regulation, found to be significantly associated with the outcome variables after the correction, predicted these outcomes once considered simultaneously with control variables. Components of Negative Emotionality were also addressed.

Results

Correlational analyses yielded several significant relationships between temperament and sleep indicators (Table 2), one of which remained after the correction: Vocal Reactivity and Sleep Problems ($r = -.385$, $p = .047$). Significant associations were also found between infant temperament and maternal feeding beliefs/practices (Table 3). A number of correlations, including Smiling/Laughter and Using Food to Calm Fussiness ($r = .522$, $p = .005$); High Intensity Pleasure and Using Food to Calm Fussiness ($r = .514$, $p = .006$); Vocal Reactivity and Using Food to Calm Fussiness ($r = .484$, $p = .011$); Vocal Reactivity and Under-Eating Concerns ($r = .505$, $p = .007$); Activity and Under-Eating Concerns ($r = .425$, $p = .027$); and Smiling/Laughter and Social Interactions ($r = .444$, $p = .020$) remained significant following this correction.

Multiple regression analyses were conducted next wherein infant temperament ratings served as predictors of IFQ and BISQ indicators, yielding a number of significant effects (Table 4). Infants' Activity Level and Vocal Reactivity scores jointly contributed to maternal ratings of Under-Eating Concerns, when introduced into the regression equation in the same step, with Vocal Reactivity emerging as the single significant individual predictor. Infants' Smiling/Laughter emerged as a predictor of more Social Interactions during feeding. Using Food to Calm Fussiness was predicted by a combination of Smiling/Laughter, Vocal Reactivity, and High Intensity Pleasure, entered in the same step; however, none of these independent variables emerged as unique significant predictors. Finally, Vocal Reactivity made a marginal contribution to explaining Sleep Problems.

Discussion

Overall, our findings indicate that there are a number of relationships between fine-grained infant temperament attributes, eating/feeding and sleep-related problems in toddlerhood. This study is unique in its prospective nature and in examining fine-grained temperament dimensions underlying the overarching factors of Surgency/Extraversion and Orienting/Regulation, in addition to those related to Negative

Table 2. Correlation analysis: IBQ-R Fine-grained Temperament Factors and Sleep Variables (BISQ).

Variables	Time Sleeping/Night	Time Sleeping/Day	Average Wakings/Night	Time Awake/Night	Latency to Fall Asleep/Night	Sleep Problems	Regular Bedtime
Activity	.002	.119	-.101	.156	.270	-.255	-.070
Distress to Limits	.468**	-.081	.014	.200	.078	-.149	-.115
Fear	.206	-.170	-.042	.111	.096	.012	-.157
Duration/Orienting	.094	.229	-.137	-.128	-.395*	-.274	-.315
Smiling/Laughter	-.203	.087	.069	-.008	.039	-.279	-.205
High Intensity Joy	-.165	.108	.286	.014	.027	-.296	-.147
Low Intensity Joy	-.316	.146	.215	-.107	-.163	-.307	-.060
Soothability	-.138	.141	.212	.391*	.005	.203	-.327
Falling Reactivity	-.144	-.090	-.200	-.425*	-.080	-.007	.111
Cuddliness	.069	-.099	.004	-.114	-.209	-.032	-.163
Percept. Sensitivity	-.342	.076	.054	.093	.112	.023	.103
Sadness	.161	-.139	.035	.339	.403*	.022	.220
Approach	-.305	.259	.352	-.201	.291	.025	-.019
Vocal Reactivity	-.119	.219	-.152	-.039	.232	-.385*	-.007

Note: * $p < 0.05$; ** $p < 0.01$.

Table 3. Correlation analysis: IBQ-R Fine-grained Temperament Factors and Feeding Variables (IFQ).

Variables	Concerns/ Under-eating	Concerns/ Hunger	Awareness: Hunger/Satiation	Concerns/ Over-eating	Feeding/ Schedule	Using Food to Calm Fussiness	Feeding Social Interaction
Activity	.425*	-.029	.075	-.242	.120	.372	-.129
Distress to Limits	.139	-.226	.031	-.184	-.104	.075	-.065
Fear	-.072	-.132	-.079	-.173	.121	-.178	-.346
Duration/Orienting	.020	-.126	.046	-.030	.250	-.224	-.043
Smiling/Laughter	.270	-.107	-.025	.086	-.033	.522**	.444*
High Intensity Joy	.356	.064	.041	-.032	.001	.514**	-.025
Low Intensity Joy	-.012	.261	.092	.256	.156	-.032	.220
Soothability	.184	.072	-.290	.089	-.116	.207	-.068
Falling Reactivity	.180	.229	-.088	.220	-.096	-.115	-.157
Cuddliness	-.142	-.014	-.157	.087	-.210	-.268	.138
Percept. Sensitivity	-.002	.188	.024	-.098	.239	.169	-.275
Sadness	.143	.082	-.181	.125	-.215	.363	-.016
Approach	.094	.303	.323	.085	.001	.350	-.278
Vocal Reactivity	.505**	.046	.169	-.024	-.095	.484*	.249

Note: * $p < 0.05$; ** $p < 0.01$.

Table 4. Multiple regression analyses.

Variable	Model 1 Beta (SE)	Model 2 Beta (SE)
Concerns/Under-eating		
Infant's Age	.409* (.036)	.291 (.033)
SES	-.299 (.008)	-.269 (.007)
Education Level	.251 (.021)	.315 (.019)
Activity Level		.141 (.264)
Vocal Reactivity		.417* (.237)
<i>R</i>	.499	.684
<i>R</i> ²	.249	.468
<i>R</i> ² Δ	.249	.219
<i>F</i>	2.438	4.117*
Feeding Social Interaction		
Infant's Age	-.532** (.031)	-.565** (.026)
SES	.028 (.007)	-.044 (.006)
Education Level	-.227 (.018)	-.056 (.015)
Smiling/Laughter		.480** (.168)
<i>R</i>	.553	.726
<i>R</i> ²	.305	.527
<i>R</i> ² Δ	.305	.221
<i>F</i>	3.223*	9.821**
Using Food to Calm Fussiness		
Infant's Age	.289 (.029)	.121 (.033)
SES	.138 (.007)	.003 (.006)
Education Level	.026 (.017)	.151 (.015)
Vocal Reactivity		-.019 (.278)
Smiling/Laughter		.376 (.330)
High Intensity Pleasure		.305 (.510)
<i>R</i>	.324	.650
<i>R</i> ²	.105	.422
<i>R</i> ² Δ	.105	.318
<i>F</i>	.859	4.348*
Sleep Problems		
Infant's Age	-.270 (.016)	-.184 (.016)
SES	-.113 (.004)	-.122 (.003)
Education Level	.102 (.009)	.023 (.009)
Vocal Reactivity		-.386 [§] (.104)
<i>R</i>	.310	.479
<i>R</i> ²	.096	.229
<i>R</i> ² Δ	.096	.133
<i>F</i>	.779	3.627 [§]

Note: * $p < 0.05$; ** $p < 0.01$; [§] $p < 0.10$.

Emotionality, most commonly examined in the past. Negative Emotionality represents a core feature of the difficult temperament construct, which has received the most attention with respect to feeding and sleep disorders in early childhood, and the results of this study indicate that components of Surgency/Extraversion are important to consider as well. In particular, Activity Level and Vocal Reactivity emerged as contributors to greater maternal concerns regarding under-eating, with Vocal Reactivity making a notable individual contribution. Not surprisingly, infants' Smiling/Laughter was demonstrated as a significant predictor of more social interactions during feeding. The use of food to calm fussiness was predicted by a

combination of Smiling/Laughter, Vocal Reactivity, and High Intensity Pleasure; however, none of these predictors emerged as more or less important. In addition, Vocal Reactivity made a marginal contribution to explaining difficulties with sleep. It should be noted that these results were obtained in the context of a fairly conservative analytic approach, controlling for the number of statistical tests with respect to simple correlations, and including the child's age, family SES and mothers' education level as covariates in multiple regression models.

Overall, the observed pattern of results is most consistent with the Vollrath et al. (2011) proposition that infants who are described as exhibiting high levels of attributes associated with Surgency/Extraversion demonstrate greater caloric needs resulting in intensified parental feeding efforts, and our results suggest concerns with under-eating as well. The latter is likely a result of parents appreciating the increased need for calories, and being concerned that this need is met. Interestingly, although activity level was significantly correlated with under-eating concerns, vocal reactivity emerged as the primary contributor to this outcome in the multiple regression analyses. It is notable that more significant associations between temperament and eating/feeding concerns were observed, relative to sleep issues. This may be a function of the fact that food-related concerns dominate during the toddler period, with the expansion of the child's repertoire of foods and the feeding routine becoming more embedded in family meals, whereas sleep-related issues represent a greater priority earlier in infancy, when the sleep routine is first being established. This particular importance of infant sleep routine has been supported by studies linking early sleep patterns with the development of cognitive abilities, and especially executive functioning (Bernier, Carlson, Bordeleau, & Carrier, 2010; Scher, 2005), as well as the quality of mother-infant interaction (de Graag, Cox, Hasselman, Jansen, & de Weerth, 2012). Although parents continue to be concerned with healthy sleep patterns well beyond infancy, the first year of life is a time of greatest strain on parents as a result of night wakings, and later concerns typically involve cooperation with bedtime routine (e.g. bedtime resistance, difficulty initiating sleep because of anxiety, etc.; Meltzer & Mindell, 2006). Thus, the direct pathway from temperament (i.e. fussiness/distress proneness) to sleep/wake regulation described by Scher et al. (1998) may be more prominent in its effects in infancy.

Our findings are somewhat inconsistent with prior research in part as a function of the differences in the designated structure of temperament (Rothbart & Derryberry, 1981). Although dimensions underlying Negative Emotionality addressed in this study (Distress to Limitations, Fear, Sadness, and Falling Reactivity) offer some conceptual overlap with previously utilised difficult temperament constructs, our results suggest that fine-grained dimensions linked with infant Surgency/Extraversion (i.e. Smiling/Laughter, Activity Level, High Intensity Pleasure, and Vocal Reactivity) are more critical to eating/feeding in the toddler period. It may be that children who are more vocal about their interests in activities other than eating (e.g. playing) and objects other than food (e.g. toys) do not demonstrate the same interest in, or possibly enjoyment of food and associated mealtime routines, thus giving parents reasons to be concerned with under-eating. Mothers of children exhibiting more extensive positive vocalisations, smiling/laughter, and high intensity pleasure, may also be reinforced by infants' positive reactions (e.g. smiling) in response to feeding efforts, leading to more frequent attempts to calm by using food. We did not evaluate whether caregivers felt their feeding to calm efforts were successful, and this should be examined in future

research to address this potential explanation. Although our results suggest that a temperament profile marked by high levels of Vocal Reactivity in particular may be a risk factor when it comes to nutritional intake and possibly growth in early childhood, Surgency-related attributes may serve a protective function with respect to later weight gain due to low energy expenditure, typically occurring shortly after school entry (American Academy of Child and Adolescent Psychiatry, 2011). It should be noted that nutritional intake, growth, or energy expenditure were not evaluated in this study, and should be examined in the future to directly address this possibility.

Fewer significant relationships emerged between fine-grained temperament indicators and sleep variables. Although Vocal Reactivity accounted for a marginally significant amount of variance in Sleep Problems, with higher levels of vocal reactivity predicting fewer sleep problems, it should nonetheless be addressed in future research. It is possible that this association is mediated by parenting/parent-child interaction factors. That is, more vocally reactive infants (i.e. babies who are more expressive vocally in the context of neutral or positive emotional tone) may evoke parenting/caregiving that in turn leads to better quality sleep. Support for this set of relationships would be consistent with the goodness-of-fit model (Thomas & Chess, 1977), in so far as a child attribute increases the probability of a parental response that in turn results in a satisfactory fit between child reactivity/regulation and caregivers' demands/expectations.

Significant associations demonstrated between eating/feeding, sleeping and fine-grained temperament dimensions related to Surgency/Extraversion support the distinction between positive and negative emotionality. Although the emotionality domain of temperament has been frequently conceptualised in terms of a continuum, with positive affect/joy representing one end, and negative emotions/distress representing the other, these have been operationalised as distinct domains in the context of the IBQ-R, consistent with the unique underlying neurobehavioural systems for positive and negative emotionality (Gray, 1991, 1996; Rothbart & Bates, 2006). Our results also support the theoretical importance of addressing temperament at the fine-grained level, in so far as differential relationships were observed for the several IBQ-R scales and the outcomes examined in this study. Thus, the present findings are consistent with research indicating more narrowly defined domains yield differential prediction with respect to multiple important childhood outcomes (Rothbart & Bates, 2006), and make a contribution to the existing literature by considering sleep and eating/feeding concerns as dependent variables. Research addressing fine-grained aspects of temperament is likely to continue to play an important role in identifying risk and protective factors, as well as in developing interventions targeting at-risk youngsters.

Some limitations of this research need to be acknowledged. First, the small sample size precluded us from examining more complex statistical models representing relationships between temperament, feeding and sleep, and adversely affected the power of statistical tests. The use of telephone interviews may be viewed as unconventional, yet this methodology offered a number of advantages. The third author (AJH) conducted every interview, followed a written script, and reiterated the answer choices throughout the session, ensuring that participants were approached in a standardised manner. The telephone interview also provided an opportunity to immediately answer participants' questions, and an instantaneous access to data, avoiding the uncertainty of receiving completed questionnaires. The use of an instrument designed for infants with a sample on the cusp of the upper

age limit, and our exclusive reliance on parent-report, should be noted. Finally, our sample size and homogeneity call into question the extent to which these findings could be generalised to the general population. Future studies should incorporate observations in the assessment of temperament, and utilise a preschool version of the feeding questionnaire included in this study. More diverse and larger samples should also be recruited.

Overall, results of this study indicate that a number of fine-grained infant temperament dimensions predict aspects of toddler eating, maternal feeding behaviours and attitudes, and to a lesser extent, sleep-related concerns. Moreover, identification of temperament risk and/or protective factors is an important endeavour because such markers could be utilised in provision of preventative services, possibly with respect to eating/feeding problems in early childhood.

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