



The relationship between child temperament and early childhood caries

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Abstract

Purpose: Among the potential risk factors associated with nursing caries/baby bottle tooth decay—a subset of Early Childhood Caries (ECC)—is a “strong-tempered” behavioral style in the child. However, the few empirical studies that have investigated this description remain controversial. The research goal of this study was to operationalize the “strong-tempered” profile and investigate its association to parental feeding practices and ECC levels.

Methods: In an observational-correlational study design, 58 children (ASA I), ages 18 to 70 months ($M=43$ months, $SD=17$), were reliably assessed for ECC levels by a clinical evaluator. A second evaluator, blind to ECC status, interviewed parents using a demographic survey, a feeding practices measure, and the EAS Temperament Survey for Children.

Results: Multiple regression analyses indicated that none of the four temperament factors (Emotionality, Activity, Sociability, and Shyness) significantly predicted duration of feeding habit defined as the length of time in months that the child breast or bottle fed, whichever lasted the longest. However, the combination of greater duration of feeding habit and higher levels of Shyness predicted all three measures of ECC: the presence or absence of caries ($r^2=.19$, $P<.001$), the number of carious teeth ($r^2=.23$, $P<.001$) and the number of carious surfaces ($r^2=.21$, $P<.001$). Furthermore, the addition of Native status significantly increased the predictive value of all of three models ($r^2=.37$, $r^2=.43$, $r^2=.29$, respectively, $P<.0001$).

Conclusion: Temperament did not predict the duration of feeding habit but together, shyness and duration of feeding habit was associated with ECC. (*Pediatr Dent* 23:5-10, 2001)

Among the goals set forth in 1979 by the World Health Organization for the year 2000, was the reduction of dental caries in children by use of sealants, increased water fluoridation, and improved awareness of oral health in the general population.¹ As we enter the next millennium, dental caries remains a significant problem among individual children and subgroups within the general population.²⁻⁴ The term Early Childhood Caries (ECC) has been coined to describe rampant dental caries in young children.^{3,5} When associated with inappropriate feeding habits, ECC results in the demineralization of the primary dentition, starting with the

maxillary anterior teeth and followed by the maxillary and mandibular primary molars. ECC in this context has been previously described as nursing caries (NC) or baby bottle tooth decay (BBTD).⁶ The National Health and Nutrition Examination Survey (NHANES III) found that prevalence rates ranged from 8% in two-year-old children to 40% in five-year-old children.^{7,8} In aboriginal groups (e.g., Inuit communities in the Northwest Territories and Navajo tribes from Arizona) NC/BBTD prevalence rates are alarmingly higher, ranging from 65-70%.⁹⁻¹¹

Temperament

The high prevalence rates and negative outcomes associated with ECC have led investigators to look beyond biological risk factors, and into the psychosocial realm, to better understand the development of this disease. To aid practitioners in identifying and preventing a subset of ECC (i.e., NC/BBTD), a “strong-tempered”¹² or “strongly-reacting”¹³ behavioral profile has been proposed. An enormous body of literature exists on these early appearing behavioral differences in childhood, known as temperament.

Temperament refers to an infant's style of interaction with the environment, and appears heritable and stable across time, but modifiable by later environmental influences.¹⁴ Multiple approaches have been taken to measure temperament in children including caregiver report, naturalistic measures, and laboratory observations. All of these methods carry relative advantages and limitations, however, there is a growing consensus that parent-report measures provide a useful perspective on child personality on a wide range of behaviors as well as a strong degree of objective validity.¹⁵ In dentistry, parent-report measures such as Toddler Temperament Scale (TTS), Behavior Style Questionnaire (BSQ), and Emotionality, Sociability, Activity (EAS) Temperament Survey for Children have been used to predict behaviors and caries in children¹⁶⁻¹⁹ Of these measures, the latter has been found to be a better predictor of later personality and behaviors.¹⁴

The development of these measures is based on seminal work by Thomas and Chess who also proposed the “goodness-of-fit” model.²⁰ According to this model, individual differences

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Table 1. Sample Questions from the EAS Temperament Survey for Children: Parent Report

<i>EAS subscale</i>	<i>Sample Questions rated on 1-5 scale 1=not characteristic of your child 5= very characteristic of your child</i>
Emotionality	Child gets upset easily
	Child tends to be somewhat emotional
Activity	Child is very energetic
	Child is always on the go
Sociability	Child makes friends easily
	Child likes to be with people
Shyness	Child tends to be shy
	Child takes a long time to warm up to strangers

in temperament accord differentially with the surrounding environment.²⁰ Particular temperament profiles “fit” better than other profiles in given situations. In this model, “poor goodness-of-fit” refers to children who become easily upset, have irregular biological functioning, and show intense and often negative reactions to environmental change. Taking care of such children is very difficult, and “poor goodness-of-fit” may elicit improper feeding practices from parents and caregivers.²⁰⁻²³ For example, parents may attempt to soothe and quiet their difficult, “strong-tempered” child with a bottle or via manipulation of the contents in the bottle, setting the stage for the development of ECC. Thus, elaborating the features of the “difficult” or “strong-tempered” child is an important ECC research goal.

The present study tested two hypotheses: First, temperament will predict duration of feeding habit defined as the age (in months) from birth to when the parent discontinued breast or bottle feeding, whichever lasted longest. Second, greater duration of feeding habits will predict higher levels of ECC.

Methods

Patient sample and design

A total of 58 healthy children (American Society of Anesthesiologist patient status Class 1), ranging from 1 to 5 years in age, were evaluated consecutively as they presented for treatment at Children’s Hospital Dental Clinic in Winnipeg, Manitoba, Canada. In an observational-correlational study design, children were assessed over a six-month period using measures of ECC, temperament, feeding behaviors and demographic variables. The eligibility criteria for this study included healthy child status (ASA I) and the presence of all four maxillary primary anterior teeth and maxillary first primary molars. Each primary caregiver was given an overview of the study and evaluations were completed after the provision of informed consent, in accordance with the guidelines of the Human Ethics Committee.

Assessment protocol and procedure

All eligible children were clinically evaluated in a dental chair using a light source, mirror, and explorer to assess the presence

or absence of carious involvement of the four maxillary primary anterior teeth and maxillary first primary molars. To increase measurement sensitivity, two continuous ECC outcome measures were used: (a) number of carious teeth (ranging from 1-6) and (b) number of carious surfaces (ranging from 1-5 per tooth for a maximum total of 30 surfaces). No radiographs were taken. In order to compute interrater reliability, a second independent examiner determined the carious rates for 18 randomly selected cases (31%).

Following the clinical evaluation, a second evaluator who was blind to the ECC status, interviewed the parents. The interview process included three components. First, a demographic survey to collect data regarding the child’s age, gender, ethnicity, number of siblings, birth order, family income, and parents’ occupation. Second, a feeding practices measure to examine the presence, duration, and timing of nursing and/or bottle-feeding. The “timing” of feeding habit was assessed by asking the caregiver

to report on putting the child to bed with the bottle and/or breast-feeding at night-time. And finally, the EAS Temperament Survey for Children: Parent Rating (a 20-item measure) was used to yield a behavioral profile based on the three-factor model of temperament: Emotionality (distress proneness), Activity (behavioral arousal), and Sociability (preference to being with others versus being alone) (EAS).¹⁴ A fourth component, Shyness (tendency to be tense and inhibited with strangers and causal acquaintances) is considered to be a derivative of Sociability. Parents rate their children on a five-point scale (1 = not characteristic, 5 = very characteristic). The EAS has demonstrated test-retest reliability ($M = .70$), internal consistency ($M = .83$) and construct validity in children 1- to 9-year-old across different cultures.^{14,24} Following the parent interview, child intervention including dental treatment options and oral health prevention was discussed as needed.

Data analysis and statistics

Interrater reliability for determining ECC status was calculated for a randomly selected subsample ($N=18$). Statistical power analysis, conducted prior to data collection, had indicated that the study sample size ($N=58$) was sufficient to detect large effect sizes for an 8-variable multiple regression model (power = .80, $P=.05$).²⁵ To ensure statistical independence of predictor variables, the four EAS factors were intercorrelated. A series of t tests were conducted to assess age, gender, and ethnicity effects on EAS subscale scores. Multiple regression analysis was used to (a) test the relationship between the four temperament factors and duration of feeding habit, and (b) determine the best combination of 8 predictor variables (Emotionality, Activity, Sociability, Shyness, duration of feeding habit, age, gender, and ethnicity) for three ECC outcome variables (presence or absence of caries, total number of carious teeth, and total number of carious surfaces).

Results

Demographics and descriptive analyses

The final sample comprised 58 children, 28 boys (48%) and 30 girls (52%), ranging in age from 18 to 70 months ($M=43$

months, SD=17). Of the sample, 37 were Native Canadian (Aboriginal descent) (64%), 12 were Caucasian (21%) and 3 were Asian (5%). For the remaining 6 children (10%), their parents selected a nonspecific ethnic category ("Other"). With regards to annual income, the study sample was in the low-to-moderate range: 38 families (66%) reported \$20,000 or less, 11 (19%) reported \$20,001-\$40,000, 4 (7%) reported \$40,001-\$60,000, 3 (5%) reported \$60,001-\$80,000, and 2 (3%) reported \$80,001 or more. The majority of the families (85%) had incomes below the provincial household average of \$43,404 CND.²⁶ Because income correlated with Native status ($r = .41$), duration of feeding habit ($r = -.38$), and shyness ($r = -.36$), it was not a good choice for entry into the regression models. Native status correlated with duration of feeding habit ($r = -.34$), but not with shyness ($r = -.02$). Thus, it was a better predictor for entry, because it was relatively independent of the other predictors, and because it was correlated with another variable of importance (income). Native Canadians comprised 79% of the lowest income group, and this lowest income group comprised 81% of the total Native sub-sample. Gender and age were entered as predictor variables in regression analyses; neither contributed significantly to duration of feeding habit or to the three ECC outcome variables.

Temperament, duration of feeding habit, and ECC

In terms of temperament, the average score of the sample was moderately emotional, highly active, highly sociable, and moderately shy. These were comparable to the sample from an earlier study.¹⁶ Results from t-tests showed no significant age or gender differences for the EAS sub-scales. Shyness and Emotionality were positively correlated ($r = 0.40$, $P = .0019$). Therefore, of the two factors, only Shyness was entered into

regression analyses in order to reduce redundancy among the predictor variables. Activity and Sociability were statistically independent of Shyness and Emotionality. Mothers provided nearly 80% of EAS ratings (46 of 58). Fathers and other primary caregivers from birth provided the remaining ratings. Parents are widely regarded as valid informants regarding the temperaments of their children.¹⁵

The mean length or duration of feeding habits reported for the sample was 21.21 months (SD=9). Because some participants were still breast- and/or bottle-feeding at the time of data collection, duration of feeding habit and age were conflated for these participants. Thus, duration of feeding habits were age-corrected (duration of feeding habit in months divided by age in months) prior to entry into regression analyses. A positive history of feeding during sleep was reported by 72% of caregivers with data missing from one child. Due to the lack of variability and missing data, this information was omitted from any further analysis. Stepwise multiple regression analysis, however, showed that none of the four temperament factors significantly predicted duration of feeding habit. Therefore, the hypothesized correlation between temperament and duration of feeding habit was not supported by our data.

Of the 58 children, 76% (N=44) were positive for caries. Among the caries group, 77% (N=34) were Native Canadian, compared to only 21% (N=3) of the non-caries group. The mean number of carious teeth was 3.7 (SD=2.5) and the mean number of carious surfaces was 12.6 (SD=10.7). Interrater reliabilities for all three ECC measures were excellent (kappas > 0.86).

Regression models using continuous measures of ECC were more powerful than when using dichotomous ECC measures (Table 2). In general, dichotomizing measures that are inher-

Table 2. Significant Predictors of Early Childhood Caries (ECC) Outcomes: Results of Multiple Regression Analyses.

<i>ECC outcome variable</i>	<i>Predictor variable</i>	<i>Proportion of outcome variance (r-squared)</i>
Presence and absence of carious teeth	Duration of feeding habit (FH)	.06 n.s.
	Duration of FH + Shyness	.19 [†]
	Native status	.25 ^{††}
	Native status + Duration of FH	.25 [†]
	Native status + Shyness	.36 ^{††}
	Native status + Duration of FH + Shyness	.37 ^{††}
Number of carious teeth	Duration of FH	.14 **
	Duration of FH + Shyness	.23 [†]
	Native status	.31 ^{††}
	Native status + Duration of FH	.35 ^{††}
	Native status + Shyness	.38 ^{††}
	Native status + Duration of FH + Shyness	.43 ^{††}
Number of carious surfaces	Duration of FH	.16 **
	Duration of FH + Shyness	.21 [†]
	Native status	.18 [†]
	Native status + Duration of FH	.26 ^{††}
	Native status + Shyness	.22 [†]
	Native status + Duration of FH + Shyness	.29 ^{††}

* $P < .05$, ** $P < .01$, [†] $P < .001$, ^{††} $P < .0001$, n.s. = not statistically significant ($P > .05$).

ently continuous reduces the statistical power of analyses from 20% to 40%.²⁷ At the same time, in clinical practice, thinking in terms of the presence or absence of disease is appropriate. We therefore report both dichotomous and continuous levels of outcome measurement in this study. Multiple regression analysis showed that duration of feeding habit and Shyness had a *statistically significant and moderate effect size* accounting for 19% to 23% of the variance in ECC, depending on the level of measurement. However, the largest proportion of variance for all ECC outcomes was explained by a linear combination of Native status, duration of feeding habit and Shyness, with Native demonstrating *statistically significant and large effect size* (Table 2).

Discussion

Temperament, duration of feeding habits, and ECC

The present study is one of the first efforts to link temperament and ECC. We found a robust two-predictor model demonstrating that shyer children and greater duration of feeding habit were risk factors for ECC. These findings pose the question of what is the practical meaning of the *moderate and large effect size* estimates found in this study? This interpretation will depend on one's framework or field of study. In the social/clinical sciences, associations between two variables are seldom larger than 0.25.²⁸ Conventions in this field indicate that, for multiple regression analyses, R-squared of 0.01, 0.09, and 0.25 can be regarded as small, medium, and large, respectively.²⁹ Clinicians, researchers, and policy makers alike are cautioned in embracing null or small findings.²⁸ Our study, however, reported moderate and large effects sizes that are not inconsequential when viewed in this scientific context. Concomitantly, when compared to other temperament studies that predict behaviors in a dental setting, our findings are similar in magnitude reported.¹⁹

To date, only two studies have investigated the relationship between temperament and ECC. One study found no differences in temperament between children with BBTD and without BBTD, but had methodological inconsistencies.¹⁷ A second unpublished study found lower Approach levels in children with BBTD compared to controls, but used a different design and BBTD definition.¹⁸ Our findings are consistent with the latter study. The two earlier studies^{17,18} used the Toddler Temperament Scale (TTS) and the Behavior Style Questionnaire (BSQ) to measure temperament. Lower levels of Approach are theoretically and conceptually comparable to higher levels of Shyness; item content analysis of the Approach/Withdrawal subscales of the TTS and BSQ suggest that they measure Sociability and Shyness.¹⁴ Because of its shorter length, the EAS Temperament Survey may be a more user-friendly measure (20 items) than the TTS and BSQ (100 items each).¹⁶

Although we hypothesized that attributes of the "difficult" or "strong-tempered" temperament profile, such as Shyness, would predict greater duration of parental feeding habits—which, in turn, would predict higher ECC levels—Shyness and greater duration of feeding habits emerged as *independent* predictors of ECC. If Shyness is related to prolonged duration of feeding behaviors, then the relationship is not a direct one. Clearly, a more complex model relating temperament, parental feeding practices, and ECC requires investigation. For example, the timing, daily frequency, amount, and content of

feeding may be as important as the duration of feeding habit, and may be significantly more related to temperament. Feeding that is timed with sleeping has been associated but has not always been consistent with increased ECC.³⁰ Although this study superficially supported this finding, given the lack of variability of this measure within this sample, it was not assessed further. Similarly, how much and how often feeding takes place are important, given that fermentation of carbohydrates by cariogenic bacteria reduces pH levels in the oral environment and promotes demineralization of the tooth structure.³ Furthermore, the type of liquid that children are fed may be critical. Although milk was believed to be a highly cariogenic substance, recent *in vitro* studies suggest that it is less cariogenic than other sugar-containing liquids.³

A key question then is, *What elicits improper feeding?* Because recent research has linked difficult temperament with feeding difficulties,³¹ investigation of the temperament—feeding relationship should continue. Child behavioral predictors of improper feeding also deserve attention in temperament—ECC research. In numerous studies conducted over the last decade, difficult temperaments have predicted sleeping difficulties in young children.³²⁻³⁶ This robust finding should be considered in light of other recent research documenting that children who exhibit sleeping difficulties are at greater risk of developing ECC.^{12,37} In both studies, this risk was attributed to the higher frequency of bottle feeding in the ECC groups, compared to the non-ECC groups. The respective authors interpreted this prolonged and improper feeding as parental behavior management of sleeping difficulties.

Yet, there is no reason to limit future investigation to sleep-related behavior management. In general, severely shy or behaviorally inhibited children are at greater risk for a wide range of behavioral disorders.^{15,22,37,38} These behavioral difficulties influence the actions of the children's caregivers, including feeding practices during the remainder of the child's waking hours. It is speculated that child's temperament may affect the parent's ability to manage the child's behavior and ultimately impact the timing, daily frequency, amount, and content of feeding, possibly setting the stage for ECC development. Here it is worth noting that the parent-child relationship is a reciprocal process, and future research should attend to parent→child, child→parent, and bidirectional parent↔child effects.

Another important finding was the reliability and validity of the EAS Temperament Survey for Children for Native Canadian respondents. The present study replicated the EAS score distributions from a previous study that included Native Canadian parents and their children.¹⁶ Moreover, the Native Canadian mean scores and standard deviations for Emotionality, Sociability, and Shyness were not significantly different from those obtained by non-Native Canadians (data not reported, but available from the authors upon request).

Native Canadian status

Stressful conditions, such as financially strained environments, exacerbate parental difficulties in providing care to temperamentally difficult children. Such conditions of risk increase the chances of "poor goodness-of-fit." Given the impoverished socioeconomic profile of Native Canadians across their country, we have emphasized that Native status in the present study indexes a much larger (and well-established) con-

stellation of disadvantage, including lower income, lone parenthood, lower education, and other risk factors for poor child health and development. Therefore, it is not surprising that knowing the Native Canadian status of the children increases the predictive power of all the regression models, nearly doubling r-squared for dichotomous and continuous measures of ECC (Table 2). Shyness and prolonged feeding habits retain their predictive relationships to ECC even after Native status, age, and gender are taken into account. However, the predictive power of prolonged feeding habits is attenuated somewhat, because of its correlation with Native status.

An important implication of the present study is that "poor goodness-of-fit" (i.e., socioeconomic disadvantage in conjunction with difficult child temperament) is associated with higher ECC levels, regardless of the outcome measurement level. The well-replicated association between poor child oral health and poor parental socioeconomic status may be due to decreased preventive measures following increased attention to more pressing and immediate matters of food, safety, and housing.³⁹ It is important to note that Native Canadians comprised 79% of the lowest income group in our study, and this lowest income group comprised 81% of the total Native subsample. Yet there is cause for hope and impetus for primary prevention efforts. Research has shown that the quality of the parent-child relationship can reduce the risk of negative outcomes, even under socio-economically adverse conditions.^{23,40}

Limitations

Some study limitations merit mentioning. First, there are limitations familiar in the use of questionnaire measures (e.g. respondent recall bias and social desirability). Although our selected temperament measure is one of the best available, and appears valid with both Native and non-Native Canadian respondents, there is room for improvement in our measure of parental feeding practices, as noted earlier. Second, there are limitations presented by parents' prior knowledge of their children's oral health state. This may have influenced subsequent child temperament ratings and reports of feeding practices. Third, not knowing how long the feeding time per day lasted may have limited a better understanding of the child's feeding experiences. Fourth, the fact that children who did not present with the maxillary incisors and primary first molars were excluded from the study may have skewed the sample since it was not established whether the etiology of the missing teeth was due to trauma or extraction of decayed teeth. Finally, the issue of ECC assessment may also be raised. Although clinical assessment showed high interrater reliability in our study, it is not sufficient to detect early interproximal decay. Radiographic ECC assessment, in conjunction with clinical assessment, is a more sensitive measure.⁴¹ However, given the age range of our sample, radiographic methods could not have been applied consistently.

In summary, the present findings represent one of the first attempts to empirically evaluate the "strong-tempered" behavioral profile described in previous studies of children at risk for ECC. Despite the lack of association between the two variables of temperament and duration of feeding habit, the moderate and significant effect size of their combined association is promising in the emerging efforts to better understand the parent-child dyad in relation to ECC. The early appearance of temperament in the life span underscores its potential role in

disease and the development of prevention, treatment, and policy strategies in pediatric dental care.

Conclusions

1. Temperament alone did not predict duration of feeding habits (corrected for age).
2. The combination of Shyness and duration of feeding habits (corrected for age) moderately predicted ECC levels.
3. The best predictor model for ECC was a linear combination of Native status, greater duration of feeding habit (corrected for age), and Shyness, accounting for 29% to 43% of the variance in caries outcomes, depending on the measure method and level.
4. Although Native Canadian status appears to be a risk factor for early childhood caries (ECC), it also represents a constellation of other risk factors for ECC, including low income and improper feeding practices.

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ABSTRACT OF THE SCIENTIFIC LITERATURE



POLICIES WITH FLUORIDE USE IN NORDIC COUNTRIES

The purpose of this paper was to review the governmental fluoride policies in the Nordic countries (Denmark, Finland, Iceland, Norway, and Sweden). Dental care is provided free to all children and by law, preventive care is given preference. The community water systems in the Nordic Countries are not fluoridated. The fluoride policy include recommendations for the use of toothpaste, supplements, chewing gum, rinses, and varnish. The use of fluoride toothpaste twice daily is the preferred and sufficient source of fluoride for the majority of their population. The concentration of fluoride toothpaste was not clearly stated for children or adults. Fluoride supplements had different dosage schedules. Fluoride varnish was used for at-risk children from 2 to 6 applications per year. More than 80% of the dentists applied varnish for caries risk children. The author recommends that government policies be based on sound scientific evidence.

Comments: It is important for the USA reader to understand the fluoride policies of the Nordic countries. They did not mention the use of professionally applied fluoride applications. **LHS**

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Government policies on fluoride utilization in the Nordic countries. Wang, N. *Acta Odontol Scand* 57(6):342-47, 1999.

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