Journal of Oral Science, Vol. 47, No. 2, 91-96, 2005

Original

Structural relationship of child behavior and its evaluation during dental treatment

Sachio Shinohara[§], Yoshiaki Nomura[†], Kaori Shingyouchi[§], Atsuko Takase[§], Masamichi Ide[§], Katsuya Moriyasu[§], Yayoi Idaira[§], Tomohide Takahashi[§], Yumiko Yamada[§], Yoko Aoyagi[§] and Yoshinobu Asada[§]

Departments of [§]Pediatric Dentistry and [†]Preventive Dentistry and Public Health, Tsurumi University School of Dental Medicine, Kanagawa, Japan

(Received 14 February and accepted 17 May 2005)

Abstract: The present study uses structural equation modeling to explore the structural relationship of child behavior type and its evaluation during dental treatment. The study population consisted of 33 children at their first visit to a pediatric dentist at the Dental Hospital of Tsurumi University. Child behavior was evaluated by the Frankl Behavior Rating Scale and the behavior evaluation scale developed by Kurosu. Factor analysis extracted 3 behavior types: escape, self-defense, and facial expression. The path diagram of structural relationships between child behavior and the Frankl Behavior Rating Scale indicated that facial expression had the strongest correlation to the Frankl Behavior Rating Scale. (J. Oral Sci. 47, 91-96, 2005)

Keywords: child behavior; structural equation modeling; Frankl Behavior Rating Scale.

Introduction

Assessment of children based on their behavior is one of the most important skills for pediatric dentists (1,2). It is empirically well known that a patient who exhibits anxiety or fear of dental treatment will present a non-cooperative attitude during treatment. Even if the dentist considers the anxiety or fear of the child during dental treatment, behavior management usually depends on the dentist's experience and subjective decisions. In some instances, treatment becomes difficult because of improper decisions by the dentist. To understand child behavior during dental treatment, emotions that generate the behaviors should be elucidated.

Previous clinical studies have documented anxiety and fear of dental treatment in children. For the evaluation of child behavior, the praxiological observation and recording of behavior have been used. Frankl et al. classified child behavior into four groups according to the child's attitude and cooperation or lack of cooperation during dental treatment (3). However, this classification, known as the Frankl Behavior Rating Scale, does not provide definite items for observation. In contrast, Kurosu et al. proposed a classification of child behavior during dental treatment that does provide 37 detailed items for observation (4). Despite this advantage, this classification, which is also well known in Japan as the Behavior Evaluation Scale (BES), does not allow for the easy observation of the 37 items in daily clinical practice.

Leventhal et al. documented that child behavior can be observed in facial expression during dental treatment and proposed classification criteria for observations of facial expression (5). However, difficulties are also encountered during detailed observation of facial expression during dental treatment. Parkin et al. investigated the correlation between one total scale and 9 subscales, and concluded that 5 or 7 subscales were useful for observing child behavior (6). As this evaluation used the visual analogue scale, calculation may be difficult. Principally, the relationship between each item and observed behavior, and

Correspondence to Dr. Yoshinobu Asada, Department of Pediatric Dentistry, Tsurumi University School of Dental Medicine, 2-1-3 Tsurumi Tsurumi-ku, Yokohama, Kanagawa 230-8501, Japan
Tel: +81-45-581-1001
Fax: +81-45-573-9599
E-mail: asada-y@tsurumi-u.ac.jp

structural relationships between each item were not fully clarified in the previous research.

In the present study, the structural relationships of child behavior during a dental visit were explored using structural equation modeling (SEM). The SEM method is a comprehensive statistical approach to testing hypotheses about relationships between observed and latent variables developed for use in the behavioral and social sciences. In this respect, we adopted the commonly used Frankl Behavior Rating Scale and BES that contain clearly defined items for observation and investigated structural relationships of child behavior.

Materials and Methods

Study Populations

Patients were 33 children making their first visit to a dentist at the Department of Pediatric Dentistry of Tsurumi University Dental Hospital between July and October 2003. Of the 33 children, 14 were male and 19 female, with an age range of 3 - 9 years (mean age, 4 years 8 month). None of the children had specific problems with anxiety or non-cooperation. Informed consent was obtained from the parents or guardians of all children.

Behavior evaluation

During the initial oral examinations, a video record of the examination was made for the evaluation of behavior of all children. The videos were evaluated by 6 pediatric dentists with more than 8 years of clinical experience. Evaluation scales for child behavior were the Frankl Behavior Rating Scale (Table1) and the BES (the latter being used with minor modification). Since some items included in the BES, such as tongue movement, could not be evaluated using the video, 8 of the 37 BES items were excluded from the evaluation. Each item of the Kurosu Behavior Evaluation Scale was translated from the original Japanese into English. These original English translations were verified by back translation performed by two independent translators.

Statistical Analysis

Cohen's Kappa was calculated for intra-examiner calibration of behavior evaluations. Modal data from the 6 examiners was used for the following analyses. First, Fisher's exact tests of two-way tables were conducted to investigate the relationship between the Frankl Behavior Rating Scale and each item of the BES. For the BES, maximum likelihood factor analysis was performed with varimax rotation to determine the correlations between observed variables and underlying latent variables. Factors with eigenvalues greater than 1.0 were extracted for inclusion in factor analysis. Initially, all items on the BES were included in the analysis. Following the analysis, items that showed factor loading of less than 0.4 were excluded and the analysis described above was repeated until all remaining items showed factor loading greater than 0.4. To investigate correlations between the latent variables constructed by the BES and their contribution to the Frankl Behavior Rating Scale, structural equation modeling (SEM) was implemented. For the evaluation of the fitness of data for the model, the goodness of fit index (GFI) and adjusted goodness of fit index (AGFI) were used. These analyses were carried out using SPSS version 12.0 and AMOS version 5.0 software (Tokyo, Japan).

Results

Our initial Cohen's Kappa evaluation of intra-examiner agreement produced Kappa values from 0.31 to 0.81. All further analysis used the median of the modal data from the six examiners.

Classification of child behavior based on the Frankl Behavior Rating Scale was as follows: 22 patients (66.7%) were classified as level 3, 5 patients (15.2%) were classified as levels 1 and 2, and 1 patient (3.1%) was classified as level 4. According to the BES, items that were dominant behaviors in more than 10% of the children were "Moving the hands"(30.3%), "Putting hands over the mouth" (24.2%), "Crying loudly"(21.2%), "Shaking the legs"(18.2%), "Moving the body left and right"(18.2 %), and "Moving the legs up and down" (15.2%). Among these items, 5 behaviors concerned the limbs. Some items of the BES could not be investigated for correlation between

Table 1 Frankl Behavior Rating Scale

Rating	Attitude	Definition
1	DEFINITELY NEGATIVE	Refusal of treatment, crying forcefully, fearful or any other overt evidence of extreme negativism.
2	NEGATIVE	Reluctant to accept treatment, uncooperative, some evidence of negative attitude but not pronounced, i.e. / sullen, withdrawn.
3	POSITIVE	Acceptance of treatment; at times cautious, willingness to comply with the dentist, at times with reservation but patient follows the dentist's directions cooperatively.
4	DEFINITELY POSITIVE	Good rapport with the dentist, interested in the dental procedures, laughing and enjoying the situation.

the BES and the Frankl Behavior Rating Scale because none of the examiners reported observing the behaviors. In addition, none of the children exhibited any of the following behaviors: "Looking at the dental equipment", "Staring at the ceiling", "Looking at the fingertips of the dentist", "Nodding the head", and "Holding up the hands". Among these items, 4 behaviors were concerned with the eyes or the face.

Cross-tabulation analysis with Fisher's exact test was used to investigate the correlation between the BES and the Frankl Behavior Rating Scale. As shown in Table 2, of the 29 items on the BES, only 8 items had a statistically significant correlation with the Frankl Behavior Rating Scale. Among them, 5 items were concerned with the limbs. No items concerned with the eyes or facial expression showed statistically significant correlation with the Frankl Behavior Rating scale.

Subsequently, factor analysis was carried out to investigate the correlations between BES items. Following repeated factor analysis as described in the Materials and Methods section, we obtained the loading matrix shown in Table 3. The following 3 factors were extracted: Factor 1, escape (5 of 6 items concern the limbs); Factor 2, self-defense (3 items concern body movement); and Factor 3, facial expression (2 items concern facial expression). All items showing significant correlation with the Frankl Behavior Rating Scale were included in the 3 extracted factors.

Finally, SEM was carried out to explore the structural relationship between BES items and their correlation with the Frankl Behavior Rating Scale. The path diagram shown in Fig. 1 indicates a possible model of structural relationship with the children's behavior. The GFI and AGFI fitness indexes were 0.771 and 0.603, respectively. Regression weights from the 3 latent variables to the Frankl were 0.21 for Factor 1, 0.33 for Factor 2, and 0.38 for Factor 3. Factor 3, facial expression, had the strongest correlations with the Frankl Behavior Rating Scale.

Discussion

Many studies have investigated the emotional stress, including fear and anxiety, of children undergoing dental treatment. These studies have been classified mainly into three groups: psychological evaluation (7-9), behavioral evaluation (10,11), and physiological evaluation (12-15). Of these approaches, behavioral evaluation may be the most practical for clinical use since the psychological evaluation of children is difficult, and special devices such as pulse oximetery are required for physiological evaluation. In terms of behavioral evaluation, various scales have been developed, such as the Frankl Behavior Rating Scale (3), the behavior evaluation score developed by Kurosu (4), the Simple and Complex Scale (6), and scales proposed by Leventhal (5) and Weinstein (16); however, none of these scales are used in the daily clinical practice of pediatric dentistry. Furthermore, the structural relationships between these items are not clearly understood.

In the present study, the most frequent classification of behavior based on the Frankl Behavior Rating Scale was level 3, followed by levels 1, 2 and 4. This result was almost identical to other research (11). However, Tanabe et al. reported that level 3 was the most frequent classification, followed by levels 4, 1 and 2 (17). However, possible confounding variables in the Tanabe et al study include the age range of the children (5 to 12 years) and the clinical setting (a regular check-up).

Observations based on the BES frequently indicated behaviors concerned with the children's limbs. Our study population was younger than that of other studies, thus the subjects could not sufficiently self-regulate the expression of their emotions. In contrast, some items such as "Looking at the dental equipment", "Staring at the ceiling", "Looking at the fingertips of the dentist", "Nodding the head", and "Holding up the hands" were not observed for any child. This may be because younger children cannot stabilize their gaze, indicating that these items may not be useful for assessing younger children in clinical settings.

While SEM was developed for use in the behavioral and social sciences, some researchers have used this method in the dental field (18,19). Data on a behavior science application of SEM in a clinical setting has only been published in one previous report, which proposed structural relationships between dental anxiety and mood in the adult population (20). However, it would seem that no report has considered structural relationships in regards to the behavior of children undergoing dental treatment. Leventhal et al. showed that facial expression is easily affected by dental treatment (5). In addition, the regression weight from Factor 3 (facial expression) in the present study showed the strongest correlation to the Frankl Behavior Rating Scale. This result was consistent with the result proposed by Leventhal et al. (5).

In conclusion, this explorative study indicated a structural relationship in the behavior of children experiencing dental treatment. Furthermore, we presented the three main latent variables for the behavior of the children: escape, self-defense, and facial expression. Observation of these latent variables in child behavior may be useful for clinical practice. However, further study is needed to confirm this model with children of different ages, using a larger sample size.

Table 2 The cross tabulation of Behavior evaluation Scale and Frankl Behavior Rating Scale

	Behavior Evaluation Scale	Frankl Behavior Rating Scale					*P*-value
	Yes:Y No:N	number of subjects					
		1	2	3	4	Total	
Looking at the dental equipment.	N	5	5	22	1	33	-
Staring at the ceiling.	N	5	5	22	1	33	-
Looking at the face of dentist.	N	5	4	21	1	31	0.563
	Y	0	1	1	0	2	
Looking at the fingertips of the dentist.	N	5	5	22	1	33	-
Looking around.	N	5	5	19	1	30	0.577
	Y	0	0	3	0	3	
Rolling the eyes.	N	5	5	21	1	32	1
	Y	0	0	1	0	1	
Closing the eyes.	N	4	4	21	1	30	0.294
	Y	1	1	1	0	3	
Blinking.	N	5	5	21	1	32	1
	Y	0	0	1	0	1	
Wincing.	N	4	4	20	1	29	1
	Y	1	1	2	0	4	
Stiffening the face.	N	4	5	22	1	32	0.333
	Y	1	0	0	0	1	
Shaking the head.	N	4	4	21	1	30	0.294
	Y	1	1	1	0	3	
Nodding the head.	N	5	5	22	1	33	-
Putting hands over the chest.	N	4	4	21	1	30	0.294
	Y	1	1	1	0	3	
Holding up the hands.	N	5	5	22	1	33	-
Moving the hands.	N	0	1	21	1	23	< 0.001
	Y	5	4	1	0	10	
Putting hands over the mouth.	N	1	3	20	1	25	< 0.001
	Y	4	2	2	0	8	
Holding the hands of the dentist.	N	2	4	22	1	29	< 0.001
	Y	3	1	0	0	4	
Beating off the equipment.	N	4	5	22	1	32	0.333
	Y	1	0	0	0	1	
Moving the legs up and down.	N	1	4	22	1	28	< 0.001
	Y	4	1	0	0	5	
Shaking the legs.	N	0	4	22	1	27	< 0.001
	Y	5	1	0	0	6	
Moving the body left and right.	N	1	3	22	1	27	< 0.001
	Y	4	2	0	0	6	
Moving the body up and down.	N	3	5	22	1	31	0.098
	Y	2	0	0	0	2	
Crying out “Oh”	N	5	4	22	1	32	0.333
	Y	0	1	0	0	1	
Asking what are you going to do?	N	5	4	22	1	32	0.333
	Y	0	1	0	0	1	
Moaning.	N	5	4	22	1	32	0.333
	Y	0	1	0	0	1	
Crying softly.	N	5	3	22	1	31	0.098
	Y	0	2	0	0	2	
Crying loudly.	N	0	3	22	1	26	< 0.001
	Y	5	2	0	0	7	
Screaming, “it hurts”.	N	4	5	22	1	32	0.333
	Y	1	0	0	0	1	
Screaming, “No, no”.	N	2	5	22	1	30	< 0.001
	Y	3	0	0	0	3	

For the Kurosu Behavior rating Scale, English expressions were not found in original or following research papers (reference No 4). The English expressions of the each item were our original translation, but the expressions were confirmed by the translation into English and followed by back translation into Japanese by two independent translators.

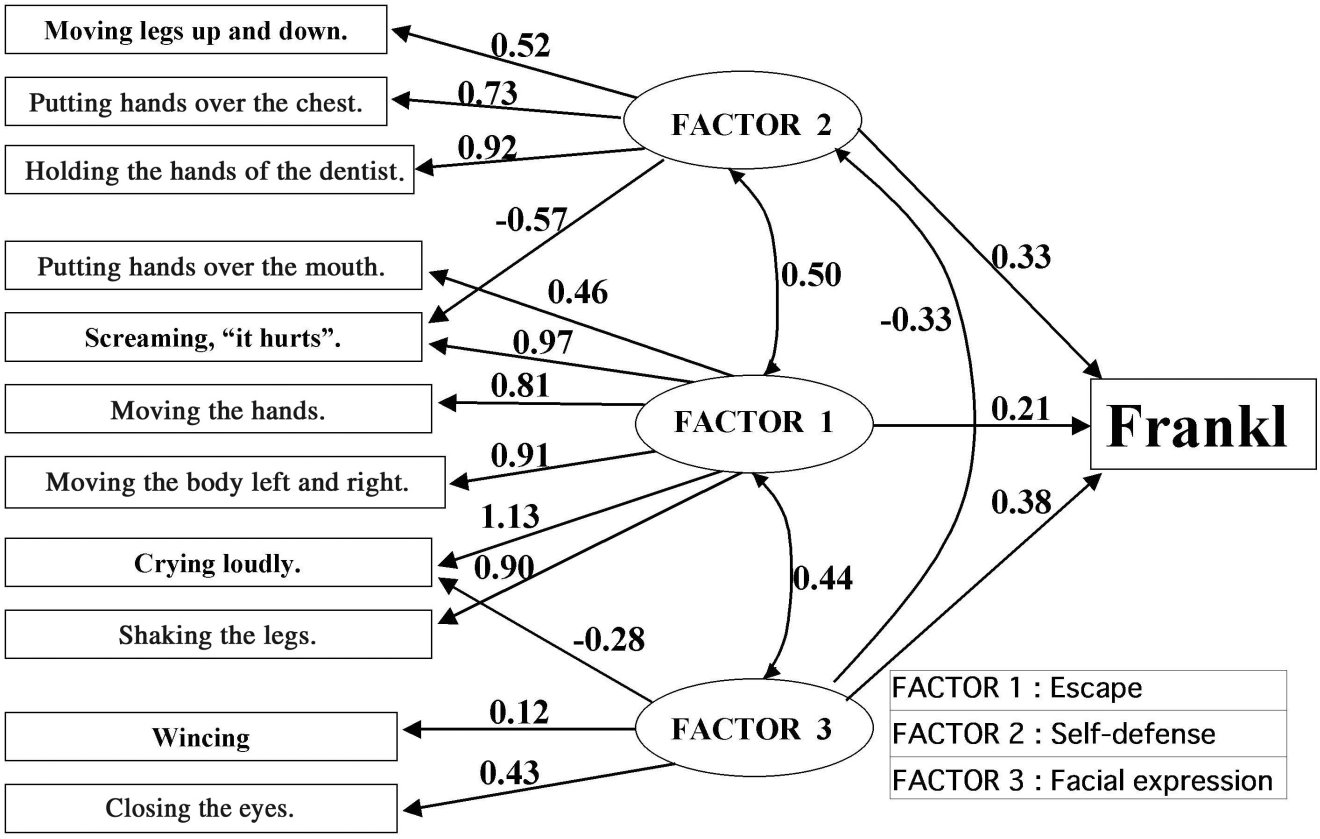

Fig. 1 The possible model of structural relationship between child behavior and Frankl Behavior Rating Scale.

Table 3 Factor analysis of Behavior Evaluation Scale items

Scale	Factor 1	Factor 2	Factor 3
Shaking the legs.	0.93	0.18	0.07
Crying loudly.	0.9	0.4	0.05
Moving the body left and right.	0.85	0.15	0.09
Moving the hands.	0.79	0.4	0.24
Screaming, "No, no"	0.75	- 0.26	0.24
Putting hands over the mouth.	0.62	0.17	- 0.14
Holding the hands of the dentist.	0.25	0.97	- 0.11
Putting hands over the chest.	0.06	0.6	- 0.1
Moving the legs up and down.	0.42	0.44	0.07
Wincing.	- 0.03	0.01	1.01
Closing the eyes.	0.14	- 0.12	0.52
Total	4.22	1.97	1.46
% of Variance	38.41	17.94	13.28
Cumulative (%)	38.41	56.35	69.63

References

1. The American Academy of Pediatric (1994) Guidelines for behavior management of The American Academy of Pediatric Dentistry. Va Dent J 71, 20-25
2. Do C (2004) Applying the social leaning theory to children with dental anxiety. J Contemp Dent Pract 5, 1-8
3. Frankl SN, Shiere FR, Fogels HR (1962) Should the parent remain with the child in the dental operatory? J Dent Child 29, 150-163
4. Tsuchiya T, Hozawa S, Waki N, Kurosu K (1975) Effectiveness of audioanalgesia in Dental Procedure. 1. Questionnaire and observation of external behavior in children. Aichi Gakuin Daigaku Shigakkai Shi 13, 184-198 (in Japanese)
5. Leventhal H, Sharp E (1965) Facial expression as indicators of distress. In Affect, cognition and personality: empirical studies, Tomkins SS, Izard CE eds, Springer, New York, 296-318
6. Parkin SF (1988) The assessment of two dental anxiety rating scales for children. ASDC J Dent Child 55, 269-272
7. Klingberg G, Lofqvist LV, Hwang CP (1995) Validity of the children's dental fear picture test (CDFP). Eur J Oral Sci 103, 55-60
8. Yamada MK, Tanabe Y, Sano T, Noda T (2002) Cooperation during dental treatment: the children's fear survey schedule in Japanese children. Int J

Paediatr Dent 12, 404-409
9. Alvesalo I, Murtomaa H, Milgrom P, Honkanen A, Karjalainen M, Tay KM (1993) The dental fear survey schedule: a study with Finnish children. Int J Paediatr Dent 3, 193-198
10. Hosey MT, Blinkhorn AS (1995) An evaluation of four methods of assessing the behaviour of anxious child dental patients. Int J Paediatr Dent 5, 87-95
11. Colares V, Richman L (2002) Factors associated with uncooperative behavior by Brazilian preschool children in the dental office. ASDC J Dent Child 69, 87-91
12. Akyuz S, Pince S, Hekin N (1996) Children's stress during a restorative dental treatment: assessment using salivary cortisol measurements. J Clin Pediatr Dent 20, 219-223
13. Sakuma N, Nagasaka N (1996) Changes in urinary excretion of catecholamines and their metabolites in pediatric dental patients. ASDC J Dent Child 63, 118-122
14. Nakai Y (1996) Behavioral science on dental fear in pediatric dentistry: relationship between behavior and the nasal skin temperature. Ped Dent J 6, 39-55
15. Yoshida T (1998) The assessment of dental anxiety: its relationships with trait anxiety, state anxiety, and nasal skin temperature. Ped Dent J 8, 45-59
16. Weinstein P, Getz T, Domoto P (1985) Temporal patterns of the behavior of young children in the dental chair. J Pedod 9, 188-199
17. Tanabe Y, Sano T, Taguchi Y, Noda T (2002) Relationship between dental fear and experience of dental injection in cooperative and uncooperative child patients - CFSS-DS in Japanese children-. Shoni Shikagaku Zasshi 40, 667-674 (in Japanese)
18. Kawamura M, Tsurumoto A, Fukuda S, Sasahara H (2001) Health behaviors and their relation to metabolic control and periodontal status in type 2 diabetic patients: a model tested using a linear structural relations program. J Periodontol 72, 1246-1253
19. Tsurumoto A, Wright FA, Kitamura T, Fukushima M, Campain AC, Morgan MV (1998) Cross-cultural comparison of attitudes and opinions on fluorides and fluoridation between Australia and Japan. Community Dent Oral Epidemiol 26, 182-193
20. Hakeberg M, Hagglin C, Berggren U, Carlsson SG (2001) Structural relationships of dental anxiety, mood, and general anxiety. Acta Odontol Scand 59, 99-103