Longitudinal Changes in Parental Satisfaction: Mixed Dentition Esthetics

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ABSTRACT

Purpose: This study's purpose was to report on parents' esthetic perceptions of their children's mixed dentition and parental satisfaction changes over time.
Methods: A total of 376 parents completed esthetic questionnaires concerning satisfaction with their children's teeth at 9- and 11-years-old. Changes in esthetic perceptions were compared based on fluorosis, nonfluoride opacity status (evaluated at 9-years-old), and other factors.
Results: A total of 36% had definitive fluorosis on permanent maxillary incisors. Fluorosis (P=.003) and opacity (P=.02) status were significantly related to reduced likelihood of parental satisfaction at 11-years-old. Parents were less satisfied with overall tooth color at 11 vs 9-years-old (P=.045), but revealed no significant change in satisfaction with overall appearance (P=.17). Shape and color concerns increased (both P=.003), while spacing concerns decreased (P=.004). Parental satisfaction increases were associated with higher socioeconomic status (P=.03) and starting orthodontic treatment (P=.002), but changes were not significantly associated with fluorosis (P=.38) or opacities (P=.81).
Conclusions: Parents were generally less satisfied with overall tooth color at 11 (vs 9) years old and had greater concerns about tooth shape and color, but fewer concerns with spacing. Improvement in parental satisfaction with overall appearance was related to higher socioeconomic status and having begun orthodontic treatment.
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Over the last 50 years, there has been a general decrease in caries prevalence in the United States and other developed countries. Coinciding with this decrease in caries rates, however, is an increase in dental fluorosis.[1,2] Studies have shown that the prevalence of dental fluorosis ranges from approximately 9% to 60% of the North American population, varying between and within nonfluoridated and fluoridated communities.[3-6] These trends of decreased caries rates and increased fluorosis rates are generally attributed to increased use of fluoridated dentifrice, other topical fluorides, dietary fluoride supplements, fluoridation of public water, and/or reconstitution of infant formula using fluoridated water.[7,8]

In the United States, dental fluorosis and other nonfluoride opacities are generally of esthetic concern only. Few studies have assessed esthetic concerns specifically involving the mixed dentition, so it is not certain how well parents understand the permanence of fluorosis vs the more transitional nature of spacing and crowding problems. Also, there currently are no published studies that have looked at changes in esthetic perceptions as the mixed dentition transitions to the permanent dentition.

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Several past studies have assessed the impact of permanent tooth fluorosis on esthetic perceptions, but these studies have been of varied design and quality, generally without the use of validated instruments. Some studies have asked respondents to view individual case photographs and assess satisfaction or acceptability or to view pairs of photographs and determine esthetic preferences.[9-12] Others have asked the children themselves (or their parents or dentists) to express satisfaction with their own teeth.[13-16] A smaller number of more recent studies, however, have tried to assess more complex aspects of psychosocial perceptions and oral health-related quality of life.[17-21] It is recommended that future studies try to use this newer, more detailed, methodological approach to enhance study validity.

McKnight et al[9] studied the esthetic perceptions of dental fluorosis vs other dental conditions, with adults being asked to compare examples of and answer questions regarding teeth displaying fluorosis vs teeth with other conditions (ie, open bite, rotated teeth, tetracycline staining, and isolated opacities). Overall, esthetic concerns were reported for many of the photographs, and ratings for teeth with mild fluorosis were less favorable than for either normal or rotated teeth. In addition, teeth with moderate fluorosis were rated as less favorable than teeth with open bite or tetracycline staining. Similar studies[10,11] using paired photographs assessed Iowa dental students' esthetic perceptions and found fluorosis to be less esthetically pleasing than opacities, but more acceptable than midline diastema. These 2 studies, however, used individual pairs of photographs for each comparison, so conclusions cannot be readily extended to the wide range of conditions found in the general population.

Edwards et al.[12] evaluated teenagers' perceptions of dental fluorosis assessing computer images of teeth corresponding to Thylstrup and Fejerskov fluorosis levels TF1 to TF4, in addition to no fluorosis (TF0). Acceptability of the images decreased as TF levels increased, with the percentage acceptable falling from 80% for TF0 to 56%, 28%, 13%, and 11% for TF1, TF2, TF3, and TF4 scores, respectively.

Lalumandier and Rozier[13] investigated parents' perceptions of dental fluorosis in Asheville, NC, with 708 5- to 19-year-olds examined using the tooth surface index of fluorosis (**TSIF**). Seventy-eight percent had some fluorosis, and parental satisfaction decreased from 74% with a TSIF score of 0 (no visible fluorosis) to 50% and 24% with TSIF scores of 2 (mild) and 4 to 7 (severe), respectively. Even with mild levels of fluorosis (TSIF=1), parents were more dissatisfied with the appearance of their children's teeth vs parents of children with no evidence of fluorosis.

Clark[22] examined the esthetic perceptions of parents, children, and dental professionals through the use of a questionnaire. It was found that all groups were able to distinguish between slides of subjects with no fluorosis and those displaying fluorosis. In addition, as the TSIF rating increased, the ratings by all 3 groups showed an increased dissatisfaction.

In connection with the Iowa Fluoride Study (**IFS**),[16] children were examined at 9-years-old and fluorosis was scored using the fluorosis risk index (**FRI**).[23] Parents then were asked to complete a questionnaire assessing their satisfaction with the appearance of their children's teeth. Consistent with previous studies, parents' esthetic satisfaction decreased as fluorosis levels increased. For children with no fluorosis, approximately 44% of parents were very satisfied with the overall tooth color of their child's teeth. For children with questionable fluorosis, 41% of parents were very satisfied; and for children with definitive fluorosis, 31% of parents were very satisfied. In addition, a greater proportion of parents were very satisfied with the overall appearance for children having no opacities (33%) compared to parents whose children had 1 or more opacities (22%).

METHODS

This study's subjects participated in the IFS. Their mothers were recruited from postpartum wards in 8 Iowa hospitals between 1992 and 1995.[7] The Institutional Review Board of the University of Iowa, Iowa City, Iowa, approved all aspects of the study. For all procedures, parents provided consent; children 7-years and older provided assent. The ongoing IFS is a longitudinal study of a cohort recruited at birth which aims to explore relationships among dental caries and fluorosis,[24,25] fluoride intake and exposures,[7,26] dietary patterns, and other factors. Since the IFS is longitudinal, changes in esthetic perceptions of parents can be followed as their children pass through their mixed dentition stage of development.

Therefore, this study's purpose is to report on parents' esthetic perceptions of their children's mixed dentition and examine changes in parents' esthetic satisfaction and concerns with their children's teeth as the mixed dentition matures from 9- to 11-years-old—the age when many parents/children seek orthodontic treatment.

A total of 630 children received an assessment of the mixed dentition at approximately 9-years-old (mean age=9.2-years-old); each had 1 parent complete a pretested dental esthetic questionnaire. Parents rated the overall appearance and color of their child's teeth on a scale of 1 to 4 (very satisfied, somewhat satisfied, somewhat dissatisfied, and very dissatisfied), and they noted aspects of concern with the teeth (ie, shape, color, alignment, spacing, crowding, and color irregularities). A more thorough presentation of the questionnaire and results of the 9-year-old esthetic assessments were previously reported.[16] At approximately 11 years old, 446 of these children returned for a bone densitometry assessment, at which time a parent again filled out a dental esthetic questionnaire. No dental exams were conducted at 11-years-old because of varied eruption patterns of the later-erupting permanent teeth. Dental exams were

scheduled for 13-year-olds instead. Only children who had the same parent complete both the 9- and 11-year-old dental esthetic questionnaires (N=376) are included in this report.

Attrition analyses were conducted comparing 9-year-old esthetic assessments, 9-year-old fluorosis and opacity case status, and demographic information among the 376 in the study sample vs the 240 that either did not return at 11-years-old (N=170) or had different parents fill out the 2 esthetic questionnaires (N=70).

The mixed dentition examinations (age 9 only) were performed by trained and calibrated dentist examiners using portable equipment and halogen headlights. Opacities were differentiated from fluorosis using Russell's criteria.[27] Fluorosis was quantified using the FRI[23] on the incisal edge, incisal third, middle third, and cervical third of the buccal surface (4 zones) of the permanent maxillary incisors. The FRI was chosen because of its utility in analytical studies of risk factors for fluorosis, and not for these analyses of esthetic perceptions.

This paper's findings are secondary analyses using the FRI results. According to the FRI, zones are scored as follows—zones with:

1. absolutely no indication of fluorosis are scored as "no fluorosis";
2. less than half of the zone containing white striations or uncertain fluorosis presence are scored as "questionable" fluorosis;
3. half or more of the zone exhibiting white striations are scored as "definitive" fluorosis (generally mild); and
4. pitting, staining, or deformity are scored as "severe" fluorosis.

Subjects with 1 or more permanent maxillary incisors exhibiting zones with definitive fluorosis were classified as "definitive fluorosis cases." Subjects with their most involved score being questionable fluorosis were classified as "questionable fluorosis cases." Subjects who had no indication of any fluorosis on the permanent maxillary incisors were classified as "nonfluorosis cases". Subjects were classified either as having 1 or more opacities or as having no opacities on the permanent maxillary incisors. Interexaminer reliability was moderately good,[28] with 65% agreement (weighted kappa=0.59) for subject-level maxillary incisor fluorosis (none, questionable, definitive), and 94% agreement (kappa=0.64) for presence of nonfluoride opacities on the maxillary incisors.

Comparisons of esthetic ratings between definitive fluorosis cases vs none/questionable and subjects with opacities vs none used the Cochran-Armitage Trend test for 3- and 4-level responses and Fisher's Exact test for dichotomous responses. The McNemar (2x2 tables) and Bowker (4x4 tables) tests of symmetry were used to assess changes in esthetic perceptions over time. These symmetry tests ignore all responses that remained the same and only assess whether the ratings that changed over time were in a positive or a negative direction. Bivariate and multivariable ordinal logistic regression assessed associations between improvement in esthetic satisfaction from 9- to 11-years-old with demographic characteristics, fluorosis, and opacities. All statistical analyses were performed using SAS 9 (SAS Institute Inc, Cary, NC).[29]

Table 1. Characteristics* of the Subjects and Families (N=376)

Characteristic	%	
Child's sex		
Male	47	
Female	53	
Parent filling out questionnaire		
Mother	97	
Father	3	
Mother's race/ethnicity		
Caucasian (non-Hispanic)	98	
African American	<1	
Asian	<1	
White (Hispanic)	1	
Educational level	**Mother**	**Father**
No response		5
High school diploma or less	16	26
Some college	25	23
College degree	42	30
Graduate/professional degree	18	16
Family income		
No response	4	
<$20,000	11	
$20,000-$39,999	38	
$40,000-$59,999	29	
≥$60,000	18	
Family socioeconomic status		
Unknown	4	
Low	15	
Middle	44	
High	37	
Orthodontic treatment initiated		
Yes	16	
No	84	

** Sex, race/ethnicity, and income were assessed at recruitment (age 0). Educational levels also were assessed at recruitment, but updated at subsequent visits. Family socioeconomic status was defined using a combination of mother's educational level and family income.*

RESULTS

Table 1 summarizes the sample's demographic characteristics. IFS subjects who remained in the study are mostly of middle to upper socioeconomic status (SES). Assessment of parental educational level was done at recruitment and updated at subsequent visits (September 2000 to January 2006), but family income was assessed only at recruitment (1992-1995). Nearly half of the fathers had college degrees, as did more than half of the mothers. Only approximately 11% of families had income below $20,000 (1992-1995), and nearly all mothers were Caucasian (98%). Using a 3-level split of SES based on mother's education and family income, 15% of children's families were low SES, 44% were middle SES, and 37%

Table 2. Parental Satisfaction Rating Percentages (for 11-year-olds) by Permanent Maxillary Incisor Fluorosis and Opacity Status (9-years-old)*

Item/question	Parent's response	N (%)	Fluorosis status at 9-ys-old (%)			P-value†‡	Opacity status at 9-ys-old (%)		P-value‡
			None (N=133)	Questionable (N=106)	Case (N=137)		None (N=309)	Case (N=67)	
Overall appearance (11-ys-old)	**Very satisfied**	111 (30)	35	32	23		31	21	
	Somewhat satisfied	204 (54)	56	52	55		54	57	
	Somewhat dissatisfied	53 (14)	8	15	19		14	16	
	Very dissatisfied	8 (2)	2	1	4	.003	1	6	.02
	Total	**376 (100)**							
Overall color§ (11-ys-old)	Very satisfied	105 (28)	32	30	23		28	28	
	Somewhat satisfied	212 (56)	59	54	56		56	57	
	Somewhat dissatisfied	51 (14)	9	15	17		14	10	
	Very dissatisfied	7 (2)	0	1	4	.004	1	4	.83
	Total	**375 (100)**							

*Percentages are column percentages.

†Tests fluorosis case vs questionable/none.

‡Cochran-Armitage test for trend of parent's response (very satisfied to very dissatisfied) for cases vs noncases (dichotomous).

§One questionnaire had an incomplete response (questionable fluorosis, no opacities).

Table 3. Parental Concern Percentages (for 11-year-olds) by Permanent Maxillary Incisor Fluorosis and Opacity Status (9-year-old)

Concern	N* (%)	Fluorosis status at 9-ys-old (%)			P-value†‡	Opacity status at 9-ys-old (%)		P-value‡
		None (N=133)	Questionable (N=106)	Case (N=137)		None (N=309)	Case (N=67)	
Shape	51 (14)	13	9	18	.06	13	15	.70
Color	167 (44)	40	48	46	.67	46	39	.35
Alignment	181 (48)	47	43	53	.20	46	60	<.05
Spacing	89 (24)	20	25	27	.26	21	36	.02
Crowding	127 (34)	34	31	36	.58	33	36	.78
Color irregularities	97 (26)	16	23	38	<.001	24	36	<.05
Other	17 (5)	4	4	6	.44	5	3	.75

*Parents were asked to mark all that applied.

†Tests fluorosis case vs questionable/none.

‡Fisher's exact test.

were high SES (4% unknown due to missing income levels). Slightly less than half of the subjects were boys. Some subjects (16%) had initiated orthodontic treatment before assessment at 11-years-old. Orthodontic treatment was significantly associated with SES, with 7%, 15%, and 22% of low, middle and high SES children, respectively, having started orthodontic treatment (Cochran-Armitage trend test, P=.005).

At the 9-year-old dental exams, approximately 35% of subjects had no fluorosis, 28% had questionable fluorosis, and 36% had definitive fluorosis based on assessment of permanent maxillary incisors. Almost all definitive fluorosis cases were mild (FRI score=2), with only 2 "severe" cases (FRI score=3). Only 18% had opacities on permanent maxillary incisors, and 4% had both opacities and definitive fluorosis on maxillary incisors.

Comparing the study sample (N=376) with subjects who either did not return at 11-years-old or had different parents fill out the esthetic questionnaires (N=240) did not reveal any significant differences in demographic qualities (see Table 1), definitive fluorosis, opacities, or 9-year-old esthetic satisfaction and concerns (all P>.05). It was noted, however, that the study sample had slightly more opacities (P=.06) and was a bit more concerned regarding alignment at the 9-year-old assessment (P=.07) vs the others who did not return at 11-years-old.

Esthetic perceptions at 9-years-old have been previously reported.[16] Parents' esthetic perceptions of their children's 11-year-old dentition are presented in Table 2. Fluorosis was negatively associated with satisfaction with overall appearance (P=.003) and overall color (P=.004). Opacities also had an adverse effect on overall esthetic satisfaction (P=.02). Fluorosis was positively associated with concerns about color irregularities (P<.001, Table 3). Presence of nonfluoride opacities was significantly associated with concern regarding alignment (P<.05), spacing (P=.02), and color irregularities (P<.05). It is notable that, among children with definitive fluorosis, 23% of parents were still very satisfied with overall appearance of the teeth, 23% also were very satisfied with the overall color, and 62% were not concerned about color irregularities. For children with opacities, 64% of parents were not concerned about color irregularities. Thus, the results showing that fluorosis and opacities are associated with less satisfaction represent only overall trends and allow for substantial variation at the individual level.

Patterns of parents' esthetic perceptions over time are presented in Table 4. Most parental perceptions remained unchanged among the 4 possible categories in overall appearance and also for specific concerns (59%-90%). The tests of symmetry, however, show that parents whose perceptions changed were more likely to report a decline in satisfaction with overall color (P<.05), increasing concern over tooth shape (P=.003) and color (P=.003), and decreasing concern over spacing (P=.004). Satisfaction with overall appearance of the teeth (P=.17) at 11-years-old and concerns about alignment (P=.93), crowding (P=.67), and other concerns (P=.25) remained fairly similar to those seen at 9-years-old. A parallel analysis using only parents who were "somewhat satisfied" to "very dissatisfied" at both ages showed the same results, except for increases in concerns with color irregularities (7% less concerned and 16% more concerned), which was statistically significant (P=.006). Additionally, there do not appear to be any substantial differences in changes in overall satisfaction (from 9- to 11-years-old) between parents of children with definitive fluorosis (21% improved vs 19% declined) vs questionable/no fluorosis (23% improved vs 15% declined), with a significance level of 0.34 from the Cochran-Armitage trend test. Changes in overall esthetic satisfaction for parents of children without opacities (22% improved vs 16% declined) were similar to changes for parents of children with opacities on the permanent maxillary incisors (27% improved vs 19% declined, P=.97).

Bivariate analyses using ordinal logistic regression for change in overall esthetic satisfaction showed no significant associations with presence of maxillary incisor fluorosis (P=.38), maxillary incisor opacities (P=.81), child's sex (P=.50), sex of the responding parent (P=.13), minority race/ethnicity (P=.79), parental educational level (P=.09 for mothers, P=.29 for fathers), or family income (P=.13). Significant associations were found with SES level (odds ratio [**OR**]=1.41, P=.03) and having started orthodontic treatment (OR=2.45, P=.002), with the OR representing a one-level improvement in esthetic satisfaction (ie, somewhat satisfied to very satisfied, or somewhat dissatisfied to somewhat satisfied). SES and orthodontic treatment were not jointly significant in a multiple regression model.

DISCUSSION

In examining the bivariate associations of dental fluorosis and parents' satisfaction with their children's teeth, it was found that parent satisfaction was lower with fluorosis occurrence, even at mostly mild levels of fluorosis (Table 2, P=.003). This result agrees with the findings of previous studies by Lalumandier and Rozier,[13] Clark,[22] Levy et al,[16] and Shulman et al,[15] and suggests that fluorosis is a factor in esthetic perceptions. Opacities also were found to be significant factors in dissatisfaction with overall appearance in bivariate analyses (Table 2, P=.02). Many parents, however, were very satisfied overall, despite the presence of fluorosis or opacities (23% and 21%, respectively). Fluorosis also was found to be a significant factor in dissatisfaction with overall color (Table 2, P=.004). This differs from the lack of effect of opacities on overall color dissatisfaction (Table 2, P=.83).

There was a tendency among parents of children with fluorosis to more often express concern about color irregularities (Table 3, P<.001) compared to parents of

children without fluorosis, although many (62%) did not express any concern. Interestingly, concerns with color did not follow the same gradient across fluorosis categories (none, questionable, definitive) as did overall color dissatisfaction (9%, 16%, 21%) and concerns about color irregularities (16%, 23%, 38%). Since we asked both about concerns with color and color irregularities, some parents probably listed their concern about fluorosis in the color irregularities item only and not color itself. The data also show that concerns about alignment, spacing, and color irregularities all were significantly associated with opacities (Table 3). No other areas of concern were found to be significantly associated with fluorosis or nonfluoride opacities in bivariate analyses.

Unlike previous studies, this study was able to look at esthetic perception changes over time. In comparing the data collected at 9 and 11-years-old, changes were observed in various categories. First, it was found that there was significantly decreased satisfaction overall (Table 4, $P<.05$) among parents concerning their children's overall tooth color from 9- to 11-years-old, but not in overall appearance ($P=.17$). Looking at more detailed areas of concern in Table 4, observations were made about increases in concern with shape ($P=.003$) and color ($P=.003$), but decreases in concern over spacing ($P=.004$) between the assessments. A parallel analysis that excluded parents who were "very satisfied" overall showed similar changes in concerns.

Nearly all of the fluorosis seen in our study sample was mild and may not necessarily be perceived as adversely affecting esthetic satisfaction. Of particular note, it might be interesting to further scrutinize the digital images of children with definitive fluorosis whose parents were very satisfied with the color of their children's teeth. Perhaps, even though all were scored with definitive fluorosis using the FRI, their fluorosis was less noticeable in some way than those whose parents were less satisfied with color. With dental exams at 13-years-old and esthetic evaluations currently underway, such a follow-up analysis might be feasible.

There are many possible reasons for this study's results. One possible partial explanation for the increased levels of dissatisfaction regarding color may be the subsequent eruption of the canines and premolars, which have a higher prevalence of fluorosis than their primary counterparts and perhaps make it more likely that the parents will notice. Additional explanations concerning the increase in concern with both shape and color could be that parents were more critical of their children's teeth as their child was maturing. Some parents might have become more aware of their children's teeth, especially those with fluorosis, following the exam at 9-years-old and questionnaire; consequently, they could have been more disapproving later of their children's teeth. Reduced concern with spacing could be due to orthodontic treatment and resultant space closure of the maxillary anterior teeth.

This study had several limitations that could have affected the results. The participants come from a limited geographic area, are relatively homogeneous demographically, and do not represent the population in general. Specifically, most mothers were Caucasian, and both parents were generally well-educated and of relatively high SES. All participants had been part of the IFS for 11 years already, so their perceptions may have been different than they otherwise would have been. Also, only 2 of the 376 children had fluorosis involving staining and/or pitting. Thus, conclusions regarding fluorosis involve mainly the effects of mild fluorosis. Also, these analyses only distinguished fluorosis cases from nonfluorosis cases, without categorizing by severity.

This study also was limited in that there was no dental exam performed at 11-years-old; therefore, parents' perceptions could not be directly compared to clinical status information gathered during an exam at the same time. Variable eruption of the permanent teeth at both 9 and 11-years-old may have influenced final results. Also, the FRI was used to score fluorosis because of its value in analytical studies of risk factors, not for these esthetic perceptions analyses. It may be less well suited for this purpose than other fluorosis indices, because the FRI requires that more than 50% of a zone be involved in order to be scored as definitive fluorosis, while most other indices generally score small portions of tooth sur-face involvement as fluorosis. Thus, the FRI may underestimate fluorosis prevalence relative to other fluorosis indices.[30] In addition, the more complex approaches to assessing psychosocial aspects and oral health-related

Table 4. Changes in Parents' Esthetic Perceptions of Child's Dentition from 9- to 11-years-old (N=376)

Item	% of responses			*P*-value*
	Improved	Same	Declined	
Satisfaction with overall appearance	22	61	17	.17
Satisfaction with overall color	17	59	24	<.05
Concern:	**Less concern**	**Same**	**More concern**	***P*-value†**
Shape	4	86	10	.003
Color	9	74	17	.003
Alignment	15	70	15	.93
Spacing	17	73	10	.004
Crowding	12	77	11	.67
Color irregularities	7	82	11	.09
Other	6	90	4	.25

** P-value from Bowker's test of symmetry. The 4x4 tables showing 9- and 11-year-old responses have been condensed to "improved," "same," and "declined" for simplicity of presentation. The Bowker's tests employ all data in the off-diagonal cells of the 4x4 original tables.*

† P-value from McNemar's test of symmetry.

quality of life[18-21] were not utilized in this study. Since a review paper recently emphasized that dental fluorosis generally is not associated with lower oral health-related quality of life, it is recommended that such approaches be utilized more in the future.[31]

Parents whose responses changed regarding 9- to-11-year-olds were more likely to become more concerned about tooth color and shape, but less concerned with spacing. Changes in overall satisfaction with color were not associated with presence of fluorosis (mostly mild) or opacities. Future research will be conducted with the same cohort of subjects at 13-years-old. At that time, both parents and children will complete esthetic questionnaires, and the children will receive dental exams. This will allow comparisons to be made between parent responses at the exam for 13-year-olds and previously gathered data, as well as between parent and child responses at the exam for 13-year-olds.

CONCLUSIONS

Based on this study's results, the following conclusions can be made:

1. Parents tend to become less satisfied with the color and shape of their children's teeth, but also less concerned with spacing as their children transition through the mixed dentition.
2. Improvement in overall esthetic satisfaction was associated with higher socioeconomic status and having begun orthodontic treatment, but changes were not significantly associated with presence of fluorosis (mostly mild) or demarcated opacities.

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