A Survey of Edentulous Patient Preference among Different Denture Esthetic Concepts

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ABSTRACT

Statement of Problem: Despite the fact that solutions to functional problems are available, successfully restoring the appearance of an edentulous patient remains a challenge.

Purpose: The aim of this survey was to determine if edentulous respondents could differentiate among three denture esthetic concepts and if there was an overall preference among the three.

Materials and Methods: Six edentulous test subjects were selected based on age and smile criteria. One wax tooth arrangement was completed according to each of the three esthetic concepts for a total of three wax tooth arrangements per test subject. The three esthetic concepts followed were natural, supernormal, and denture look. Standardized full-face digital photographs were made of each arrangement (three) during maximum smile for each subject (six). These 18 photographs were included in a questionnaire. Respondents were asked questions about their preference among the three randomly ordered concept photographs for each of the six subjects. A total of 147 completed questionnaires were analyzed.

Results: Ninety-six percent of respondents were able to differentiate among the three esthetic denture concepts. Natural tooth arrangements were preferred by 55% of the respondents, supernormal tooth arrangements were preferred by 19%, and the denture look arrangements were preferred by 26%.

Conclusion: Within the limitations of this survey, the questionnaire respondents differentiated between the three esthetic denture concepts. The tooth arrangement most closely resembling the anatomical average was selected by 55% of the respondents. Preference for a particular concept changed when responses to each test subject set were considered individually. Demographic factors do not significantly affect patient preference.

CLINICAL SIGNIFICANCE

Three esthetic concepts for complete denture construction have been differentiated. Questionnaire respondents preferred appearances that are far from the anatomical average 45% of the time.

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INTRODUCTION

Complete denture construction techniques have resulted in a high degree of patient satisfaction.[1,2] Traditionally discussed predictors of success include functional and comfort-related concerns.[3–8] Where conventional improvements fail, the long-term success of dental implants has allowed dentistry to address many of the functional and comfort-related problems that previously resulted in complete denture failures.[9–14] The esthetic placement of prosthetic teeth may therefore no longer be limited by arrangement techniques that stress functional concerns. In contrast to comfort and function, restoring the appearance of an edentulous patient has received little attention in modern prosthodontic literature. Several authors have found evidence that esthetics is the predominant factor in complete denture success.[15–18] A survey by Vallittu and colleagues[15] found that patients wearing removable dentures considered appearance to be the most important property of the prosthesis. Brewer[16] demonstrated through a limited clinical trial that denture patients almost exclusively chose the more esthetic denture over a denture with better comfort or function. Lefer and colleagues[18] had statistically significantly fewer adjustment appointments and a greater number of satisfied patients when all esthetic decisions were made by the patient. The psychological importance of a pleasing dental appearance is clear[19] and is often discussed in regards to denture success.[20–26] A common conclusion made by these authors was that clinicians often fail to appreciate the significant positive influence that denture esthetics can have on the overall success of the treatment.

Research in esthetics has focused on the dentate patient. Dentate patient-preference studies[27–36] and evaluation of dentate norms[37–53] may provide significant information for complete denture tooth arrangement. However, application of these findings may be inappropriate because an edentulous patient's perception of how teeth should look may be different from that of a dentate patient.[15,54,55] Few defined goals or standards exist in regard to complete denture esthetics.[56] This complicates the already challenging edentulous situation. Frush and Fischer[57–62] described a concept that seeks to match anatomic determinants of gender, age, and personality. Because the majority of these determinants come from the evaluation of dentate patients,[37–53] this concept was described by Frush and Fischer as a *natural* appearance.[62] Another esthetic concept has been described by one of the authors as *supernormal*.[63] Shor and colleagues define the supernormal concept as "attractive, idealized, and above-average dental esthetics." This concept is a patient-centered approach that allows alterations from what may be normal to provide patients with what they regard as beautiful. As this may result in an appearance that transcends the laws of nature, it can be described as beyond normal. Information to achieve this goal is found in the evaluation of patient-preference studies[27–36] and through methods used to determine the body image of each individual patient.[17,18,23,24,64–66] Recent past editions of removable prosthodontic texts continue to advocate functionally oriented tooth positions that may affect appearance.[67] Historically, a third esthetic concept developed as a result of this functionally oriented tooth positioning, as well as from common errors in fabrication and appearance for complete denture wearers.[68–71] This gave rise to appearances that people associated with a set of false teeth. Vig[68] described this appearance as a "denture look." Even if a denture look is not acceptable,[69–72] elderly edentulous patients may be accustomed to such an appearance. Popular opinion and reinforcement may dictate that long-term edentulous patients come to expect and even prefer such an appearance.

It is the authors' opinion that even though at least three distinct esthetic complete denture concepts exist, still there is little guidance to the clinician for this critical aspect of edentulous rehabilitation. However, by differentiating the three

concepts, it may be possible to establish more objective definitions and to find a preference. This would allow the clinician to more efficiently evaluate patient appearance and perhaps facilitate successful complete denture esthetics.[16–18]

A search of the English language peer-reviewed literature dating back to 1880 failed to find an investigation of edentulous patient esthetic preference. Therefore, the purpose of this investigation was to determine if edentulous survey respondents could differentiate among three different denture esthetic concepts and whether a preference existed for any of the concepts. The null hypotheses were that respondents will not differentiate between the three esthetic concepts, respondents will not indicate a preference, and demographic factors will not influence the preference.

MATERIALS AND METHODS

Six test subjects were selected from the University of Washington graduate prosthodontic clinic. Informed consent was obtained from these six subjects according to the criteria set forth by the University Human Subjects Review Committee. One male and one female patient were selected for each of the three age groups (±3 years of age): lower age (30 years old), middle age (50 years old), and upper age (70 years old). Other inclusion criteria included the following: edentulous in both arches, new prosthesis required, willing to accept study protocol, and minimum current denture tooth display of 8 mm measured by a ruler at the maxillary central incisor during maximum smile. This was an estimate of the lip mobility and helped assure that adequate display would be present for evaluation.

After selection of the six test subjects, complete denture therapy was begun for each subject. Three identical record bases were fabricated on the definitive casts in the following manner. After lubricating the cast with tin-foil substitute (Al-Cote, Dentsply Caulk, Milford, DE, USA), undercuts were blocked out using wax (Truwax, Dentsply Caulk) and a soft tissue conditioner (Lynal, Dentsply Caulk) prior to application of pink autopolymerizing acrylic resin (Orthodontic Resin, Dentsply Caulk) via the sprinkle-on method. This method resulted in three well-fitting bases that facilitated trial evaluation. Each of the three record bases was used for one of the three tooth arrangements. Tooth selection was made at the definitive impression appointment. At this visit two investigators independently selected denture tooth mold, size, and length/width proportion based upon the anatomical average for the patient gender, age, and size. Teeth selections are listed in Table 1. These selections were compared and, when necessary, a single mold was agreed to after discussion. This set of teeth would be used for the *natural* arrangement. After the natural arrangement teeth had been selected, a set of teeth 1.5 mm longer and 1 mm wider was arbitrarily selected as the teeth for the *supernormal* arrangement. Likewise, a set of teeth 1.5 mm shorter and 1 mm narrower than that selected for the *natural* arrangement was chosen and used for the *denture look* arrangement. Teeth not exactly matching the length/width alterations were slightly trimmed or waxed to the proper dimensions. All three tooth set selections were the same shade based upon the subjects' age. Patient input was disregarded and tooth alterations were conducted for the purpose of creating the three appearances.

Prior to initiation of the tooth arrangement appointment, several universal esthetic goals were agreed upon for all three concepts. The maxillary midline was made coincident with the facial midline and perpendicular to the interpupillary line. All posterior teeth were anatomic and selected to match the size and proportion of the anterior teeth. Due to the nature of the project, the occlusal scheme was not allowed to influence the position of the teeth in any of the arrangements. All arrangements had a minimum anterior horizontal and

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TABLE 1. TOOTH SELECTIONS.

	30-Year-Old Female	30-Year-Old Male	50-Year-Old Female	50-Year-Old Male	70-Year-Old Female	70-Year-Old Male
Natural	Figure 1	Figure 4	Figure 7	Figure 10	Figure 13	Figure 16
Brand	Portrait IPN	Portrait IPN	SR Vivodent PE	SR Antaris	Blueline	Trubyte Trublend SLM
Anterior mold	22E/H	12E/N	A36/A7	A15/A8	A54/A5	11H/S
Length/width ratio	10.5 mm/8.5 mm	10.5 mm/8 mm	10.3 mm/8.6 mm	11 mm/9 mm	9.5 mm/8.8 mm	11.5 mm/9 mm
Posterior mold	732—Euroline	732—Euroline	PU-3—SR Postaris	PU-3—SR Postaris	PU-2—SR Postaris	734—Euroline
Supernormal	Figure 2	Figure 5	Figure 8	Figure 11	Figure 14	Figure 17
Brand	Portrait IPN	Portrait IPN	SR Antaris	SR Antaris	Blueline	SR Vivdent PE
Anterior mold	62G/K1	21E/O	A37/A8	A17/A9	A15/A8	A17/A9
Length/width ratio	11.75 mm/9 mm	12 mm/9 mm	12 mm/9 mm	13 mm/10 mm	11 mm/9 mm	13 mm/9.8 mm
Posterior mold	734—Euroline	732—Euroline	PU-4—SR Postaris	PU-4—SR Postaris	PU-3—SR Postaris	PU-4—SR Postaris
Denture look	Figure 3	Figure 6	Figure 9	Figure 12	Figure 15	Figure 18
Brand	Portrait IPN	Portrait IPN	Portrait IPN	SR Antaris	Blueline	Trubyte Trublend SLM
Anterior mold	32B/C	13E/H	32B/C	A68/A7	A11/A3	42G/P
Length/width ratio	9 mm/7.5 mm	9 mm/8 mm	9 mm/7.25 mm	9 mm/9 mm	8 mm/7.5 mm	10 mm/8.5 mm
Posterior mold	730—Euroline	730—Euroline	732—Euroline	PU-1.5 mm—SR Postaris	PU-1—SR Postaris	732—Euroline

Portrait IPN, Euroline IPN, Trubyte Trublend SLM; Dentsply International, York, PA, USA.
SR Antaris, SR Postaris, Blueline, SR Vivodent PE; Ivoclar Vivadent, Amherst, NY, USA.

vertical overlap of 1 mm. Once determined, all three arrangements were completed at the same occlusal vertical dimension. The maximum allowed gingival display at full smile was 3 mm measured with a hand ruler.[28]

After verification of the maxillomandibular relationship record and articulation procedures, all of the maxillary anterior and posterior teeth for the *natural* arrangement were positioned chairside. The mandibular anterior teeth were also set chairside. Guidelines followed for the *natural* arrangement are summarized in Table 2. After initial verification by one of the authors, the subject was allowed to leave. The *natural* arrangement was completed by positioning the remaining mandibular posterior teeth to achieve the desired appearance. Occlusal principles were not allowed to dictate tooth position. This arrangement was then used as the reference for the other two concept arrangements.

The *supernormal* and *denture look* arrangements were completed in the laboratory. This was done by first indexing the *natural* maxillary arrangement with the use of a facebow transfer assembly (Hanau Springbow; Teledyne/Waterpik, Ft. Collins, CO, USA) and medium-body vinyl polysiloxane (Aquasil, Dentsply Caulk). Once the reference arrangement was recorded, it was removed from the cast. The transfer assembly was then arbitrarily moved 2 mm coronally and 2 mm facially for the *supernormal* arrangement by loosening the screws and moving the bracing arms. The teeth selected for the *supernormal* arrangement were then aligned using the index and luted to one of the two remaining record bases that was now positioned on the maxillary cast. Once all maxillary teeth were in position for the *supernormal* arrangement, the *natural* arrangement was placed back on the maxillary cast and the

TABLE 2. GUIDELINES FOR *NATURAL* ARRANGEMENT.

	Guidelines Used for Natural Arrangement
Extraoral	Nasolabial angle = 100 degrees[37,52]
	Mentolabial angle = 140 degrees[37,52]
	VDO preventing overclosed appearance[36,72]
	VDO allowing competent lips
	VDO allows relaxed extraoral musculature
Occlusal plane	Placed slightly below the commissure of the lips in the mandibular premolar area[56]
	Maxillary incisal plane following lower lip line[28,33–35]
Tooth selection	Size/proportion matching averages for gender, age, and size[46–48]
	Selected teeth altered to appear age appropriate[53,58,60]
Tooth arrangement	Teeth positioned visually according to above parameters
	Tooth display determined by age and soft tissue anatomy/mobility[42–45]
	Midline coincident and perpendicular[28,38]
Characterization	Subtle dental restorations when age appropriate
	Diastematas, rotations, and angulations to avoid ideal symmetry
	Skeletal jaw relationship dictated dental classification
	Anatomically correct color and contour waxing

VDO, vertical dimension of occlusion.

TABLE 3. GUIDELINES FOR *SUPERNORMAL* ARRANGEMENT.

	Guidelines Used for Supernormal Arrangement
Extraoral	VDO = same as natural arrangement[36,72]
Occlusal plane	Maxillary incisal plane following lower lip line[28,33–35]
Tooth selection	Size/proportion above averages for gender, age, and size[27,33]
	Teeth unaltered to appear ideal
	Square teeth for men, ovoid or square for women[30,33]
Tooth arrangement	Teeth positioned according to *natural* arrangement
	2 mm facially and 2 mm incisally
	Tooth display maximized by above changes
	Teeth arranged symmetrically[27,32,65]
	Midline coincident and perpendicular[28,38]
Characterization	Anatomically correct color and contour waxing

VDO, vertical dimension of occlusion.

indexing jig repositioned to it. Once realigned, the *natural* arrangement was again removed and the index now arbitrarily moved 2 mm apically and 2 mm lingually for the *denture look* arrangement.

With all maxillary teeth now positioned for all three concept arrangements, the index was removed from the articulator to allow the arrangement of the mandibular teeth according to the maxillary arrangements now in place. As mentioned previously, no change was made in the occlusal vertical dimension and an anterior open bite was maintained. Following completion of initial tooth arrangements, concept specific alterations were made as listed in Tables 2 to 4. A final anatomically contoured and textured waxing was then completed using multiple custom-shaded pink, red, and brown waxes (Truwax, Dentsply Caulk) to mimic actual gingival appearance for both the *natural* and *supernormal* arrangements. The *denture look* arrangement was waxed flat using a single shade of pink wax incorporating red fibers to mimic commonly used denture base acrylic resin. Tooth position dictated the border contours of the dentures. The resulting effects upon the soft tissue were encouraged as another means of differentiating between the concepts. The final tooth arrangements were then polished. Guidelines used for the arrangements are listed in Tables 2 to 4.

A final trial evaluation was conducted with two investigators to assure that the three concepts were properly represented. Identified discrepancies were corrected with mutual agreement among the authors. Next, full-face frontal photographs during maximum smile were made while the subject wore each of the three concept arrangements. Maximum resolution images were made using a digital camera

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TABLE 4. GUIDELINES FOR *DENTURE LOOK* ARRANGEMENT.

	Guidelines Used for Denture Look Arrangement
Extraoral	VDO = same as *natural* arrangement[36,72]
Occlusal plane	Maxillary incisal plane arranged flat disregarding lip line[71]
Tooth selection	Size/proportion below averages for gender, age, and size[68] Texture and anatomy of teeth removed with heavy pumice[68]
Tooth arrangement	Teeth positioned according to *natural* arrangement Moved 2 mm lingually and 2 mm apically Tooth display minimized by above changes[68] Teeth arranged in occlusal-oriented arrangement[67,70] Symmetrical circular curve of arch arrangement[69] Midline coincident and perpendicular[28,38]
Characterization	Flat waxing filling embrasures[68,71] Single-color pink wax with fibers[68]

VDO, vertical dimension of occlusion.

Figure 1. Thirty-year-old female subject—natural.

(Fuji S1-pro; Fuji Photo Film Co., Tokyo, Japan). The same black background, lighting conditions, chair position, and camera-to-subject distance were used for all photographs of all subjects. Complete denture therapy was then completed for each subject after they chose their favorite of the three arrangements. The previously mentioned procedures were completed for each of the six test subjects prior to final image evaluation. Final image evaluation was conducted by all authors to assure unanimous agreement that the three esthetic concepts had been clearly demonstrated.

Color photographs, 8 × 10 inches, were printed from the digital images. These photographs were then arranged in booklet format. The three photos of each subject were randomly arranged so that the three concepts were not displayed in a consistent order for each subject's face. The six "subject sets" were then randomly ordered within the photograph booklet to avoid any visible pattern in age or gender. This resulted in a booklet of 18 photographs (6 subjects × 3 arrangements). Each subject set was numbered and each of the three photos within the set assigned a letter. A label affixed to the upper right-hand corner of the photo allowed identification. The final images are shown together in Figures 1 to 18.

Figure 2. Thirty-year-old female subject—supernormal.

Figure 3. Thirty-year-old female subject—denture look.

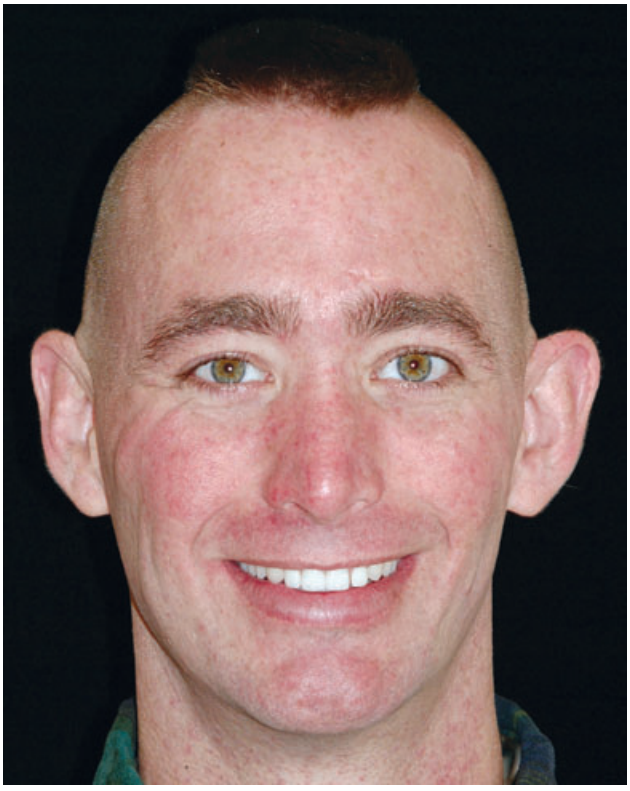

Figure 4. Thirty-year-old male subject—natural.

Figure 5. Thirty-year-old male subject—supernormal.

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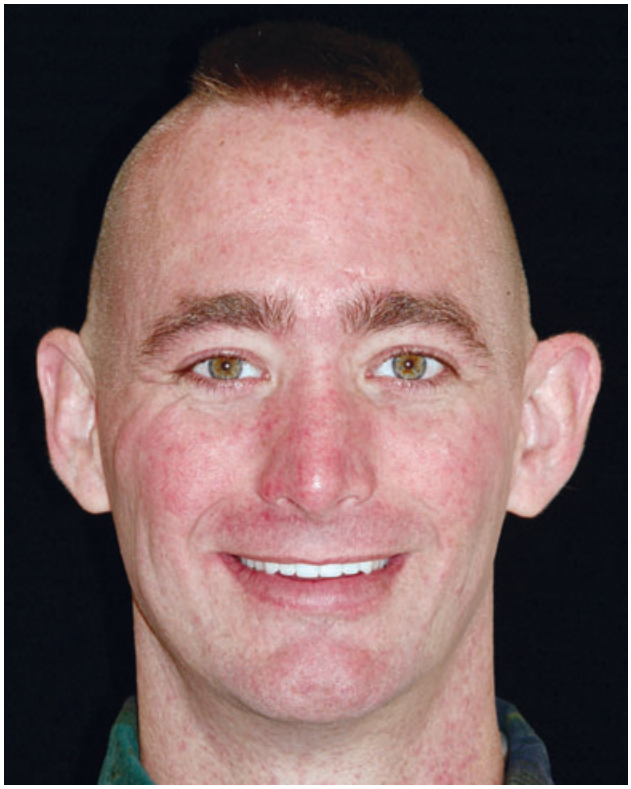

Figure 6. Thirty-year-old male subject—denture look.

Figure 7. Fifty-year-old female subject—natural.

Figure 8. Fifty-year-old female subject—supernormal.

Figure 9. Fifty-year-old female subject—denture look.

Figure 10. Fifty-year-old male subject—natural.

Figure 11. Fifty-year-old male subject—supernormal.

Figure 12. Fifty-year-old male subject—denture look.

Figure 13. Seventy-year-old female subject—natural.

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Figure 14. Seventy-year-old female subject—supernormal.

Figure 15. Seventy-year-old female subject—denture look.

Figure 16. Seventy-year-old male subject—natural.

Figure 17. Seventy-year-old male subject—supernormal.

Figure 18. Seventy-year-old male subject—denture look.

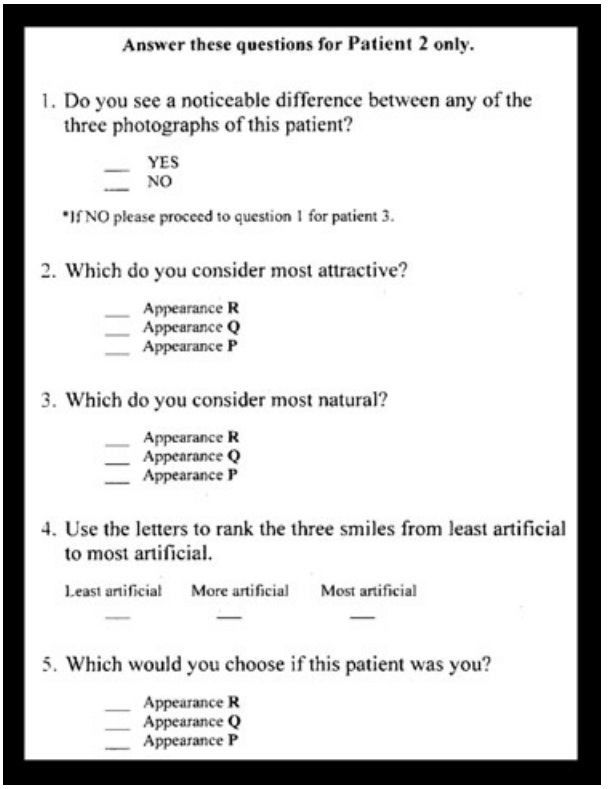

Figure 19. Survey question page for patient 2.

A large-font typed questionnaire was then created. A pilot study was conducted to evaluate the respondent's ability to visually assess the photos. Figure 19 shows the questions that were used for each subject set. Data collection was conducted by one investigator at the University of Washington. Data were collected in private practice locations by prosthodontists calibrated for the study protocol. Inclusion criteria for the respondents included the following: currently edentulous in both arches, literate English speakers, willing and able to complete the survey in a single sitting. Edentulous patients treated with dental implants were included as long as the implant positions did not affect tooth arrangement. The first 20 patients willing to take the survey a second time were used to determine reproducibility of the survey. The Kappa statistic was determined for this group. Statistical analysis using a Chi-squared test at a 0.05 level of significance was conducted for those associations the descriptive statistics deemed important or possibly significant.

RESULTS

Results are summarized in Table 5. Of those patients eligible to complete the survey, 8 declined to complete the survey and 10 were excluded from data analysis due to failure to properly (7) or entirely (3) complete the questionnaire. A total of 147 surveys were completed by edentulous patients and used for the data analysis. Eighty-eight respondents were female and 59 were male. The respondents included 131 Caucasians and 16 non-Caucasians with a mean age of 61.2 years.

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TABLE 5. OVERALL RESPONSE TOTALS FOR 147 SURVEYS.

Question	Yes	No	Natural	Supernormal	Denture Look	Blank
1	849 (96%)	33 (4%)				
2			451 (53.5%)	190 (22.5%)	202 (24%)	39
3			469 (56%)	151 (18%)	223 (26%)	39
4.1			441 (54%)	145 (18%)	227 (28%)	69
4.2			286 (36.5%)	195 (25%)	303 (38.5%)	98
4.3			70 (9%)	451 (58%)	257 (33%)	104
5			464 (55%)	165 (19%)	220 (26%)	33

TABLE 6. SELECTED CHI-SQUARED TESTS VERSUS HYPOTHESIS OF 2 : 1 : 1 PREFERENCE RATIO.

Comparison	Probability	Degrees of Freedom	X^2 Statistic	Significance Level
Upper age (≥61 yrs)	0.638	2	1.8	N.S.
Higher income (>$30,000/year)	0.831	2	0.37	N.S.
Lower income (<$20,001/year)	0.57	2	1.12	N.S.
Time edentulous (≥10 yrs edentulous)	0.42	2	1.73	N.S.
Female	0.77	2	0.51	N.S.
Male	0.57	2	1.12	N.S.

N.S. = not statistically significant.

Maximum age was 92 and minimum age was 26. Seventy-six respondents were over 60 years of age, with eight respondents below the age of 41. Eighty-three respondents had been edentulous for over 1 year and 64 had been edentulous for less than 1 year. Sixty-seven respondents had at least a high school education and 80 had at least a technical college degree. Forty-three respondents had incomes below $15,000 per year while 18 made over $60,000 per year. Forty of the respondents currently had dental implants and 70 patients selected function as the most important property of dentures. Patients were able to determine a difference among the three appearances 96% of the time. This was not affected by the respondent's age, gender, or other demographic factors. No difference could be found between the responses to questions 2, 3, or 5 as agreement was within ±3% points. Question 5 was therefore used for the following analysis, unless otherwise indicated.

When patients noted a difference, *natural* was preferred by 55% of respondents, *supernormal* was preferred by 19%, and *denture look* was preferred by 26%. The descriptive data are shown in Table 5. The overall preference ratio was accepted as the expected ratio for subsequent statistical analysis in order to determine any demographic interactions.

When analyzed by respondent age, gender, income, education, time edentulous, implants, treatment setting (dental school or private practice), or patient focus (esthetics or function), the percentages did not statistically significantly change, as shown in Table 6. However, preference differences were seen when the responses were separated by test subject age and gender. These differences are shown in Table 7, with the statistical analysis versus the new expected ratio in Table 8. Responses to four of the six test subject sets were statistically significantly different from the new

TABLE 7. RESPONSE TOTALS FOR QUESTION 5 ONLY.

Test Subject	Natural	Supernormal	Denture Look	No Difference
Overall	464 (55%)	165 (19%)	220 (26%)	33
Lower-age female	62 (43%)	26 (18%)	57 (39%)	2
Lower-age male	101 (70%)	16 (11%)	28 (19%)	2
Middle-age female	87 (61%)	13 (9%)	43 (30%)	4
Middle-age male	91 (62%)	20 (14%)	35 (24%)	1
Upper-age female	69 (52%)	23 (18%)	40 (30%)	15
Upper-age male	54 (39%)	67 (49%)	17 (12%)	9

Total number of responses per choice is listed with percentage of responses who noticed a difference in parentheses.

TABLE 8. CHI-SQUARED TESTS VERSUS HYPOTHESIS OF 2 : 1 : 1 PREFERENCE RATIO.

Test Subject	Probability	Degrees of Freedom	X^2 Statistic	Significance Level
Lower-age female	0.01	2	9.17	0.025
Lower-age male	0.0093	2	9.34	0.025
Middle-age female	0.038	2	6.53	0.05
Middle-age male	0.307	2	2.36	N.S.
Upper-age female	0.66	2	0.831	N.S.
Upper-age male	1.16×10^{-13}	2	>30	0.0005

N.S. = not statistically significant.

expected ratio. In other words, the responses to four of the six test subjects were significantly different from overall preference percentages of 55:19:26%.

When patients responded to question 4.3, natural was selected by 9% of respondents, supernormal 58%, and denture look 33%, indicating that the *natural* arrangement was rarely (9%) selected as the most artificial arrangement. Question 4 was a ranking question that saw a higher number of blank responses. The overall Kappa value was 0.625 but varied according to test subject. Responses to the middle-aged female photo set had the lowest Kappa value at 0.219, while responses to the middle-aged male were the highest at 0.783.

DISCUSSION

This survey was designed knowing that differences in patient perception exist. The differences among the three denture arrangements are only conceptual. The authors are not advocating a particular denture esthetic concept over another. The three denture esthetic concepts were used as a reference tool to determine if edentulous respondents perceived a difference. The vast majority of survey respondents were able to discern a difference between the three concept photographs. Extraoral differences in the photographs other than the change in oral appearance were minor and not considered significant. Therefore, the null hypothesis, that respondents would not be able to differentiate between the three concepts, was rejected. Respondents showed a 2:1:1 preference ratio for natural compared to supernormal and denture look. The null hypothesis that respondents would not show an esthetic preference was rejected. This ratio was maintained for all demographic interactions. The null hypothesis

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that demographic factors will not influence the preference was therefore accepted.

The three denture esthetic concepts used in this investigation had not been previously defined using specific guidelines. If a preference exists for these survey respondents, then the guidelines and references used in Tables 2 to 4 may be helpful in reproducing the various esthetic concepts. Overall, a classification for the types of appearance will aid discussion in the literature as well as with patients. This study investigated the preference of an exclusively edentulous population. Because this group of patients may have significantly different opinions about dental appearance, it would be advisable to conduct an evaluation of dentate patient preference using the same criteria. This would help clarify if edentulous patients expect or prefer a similar appearance to that of dentate subjects.

Ideally, a clear preference for a certain concept of esthetics would provide a dentist with a reasonable place to begin esthetic evaluation. This may reduce miscommunication and clinic time. However, this study suggests that no clear preference exists and it therefore reinforces the necessity for treatment time and patient involvement as the keys to patient acceptance of denture esthetics.

By using this study design, a bias toward the *natural* concept was accepted. This was required in order to compare the three concepts. The *natural* concept resulted in appearances that were attractive but not ideal. The supernormal concept, as used in our comparative design, resulted in what the authors felt were several unattractive appearances. The same was true for the *denture look* concept. The authors were concerned that patients may not have been able to differentiate a less dramatic difference in the appearances. Due to this concern, the arbitrary measurements for tooth repositioning and length/width proportion changes were a deliberate attempt to achieve the desired effect of either increase or decrease in tooth display and size. Even without prompting as to the esthetic differences, respondents quickly recognized the photographs as either attractive or artificial. It is therefore very interesting that despite the fact that the natural concept was created to be attractive and the others created to represent opposite extremes, patients selected the extremes with regularity. Any esthetic bias or assumption by the restorative dentist may therefore become evident during the trial arrangement evaluation. It has already been shown that the dentist's perception is often quite different from that of patients.[27–29] This preference survey demonstrates a similar trend. However, when patients were asked which of the three appearances was the most *artificial*, the natural arrangement was rarely (7%, ±3%) chosen. A vast majority of the surveyed population therefore selected this concept first or second. A logical follow-up study would be to compare a natural appearance with a supernormal appearance created more true to that described by Shor and colleagues. This may include less dramatic alterations in tooth repositioning and length/width proportion changes.

The most significant factor was the appearance of the test subject. The preference of a particular concept changed depending upon how each concept appeared in a particular test subject. This demonstrates how perception is to some degree unique, both for the viewed and the viewer.[65] Indeed, each survey respondent has their own body image, which affects their preference selections.[23,24,64] Body image can be simply described as the manner in which persons view themselves. Body image is complex and individual in nature. It is therefore difficult to investigate how it affects facial esthetic preference. The closest results to this question can be found when the age and gender of respondents was matched to the closest age and gender test subject. However, the small sample size for these specific groups may not provide the authors with enough data

for valid conclusions. This again demonstrates the unique nature of esthetics and the challenges in generalizing appearance for an entire population.

A more specific analysis of edentulous patient esthetic preference would include fabricating the three arrangements for each patient and asking their opinion of the arrangements after a period of time wearing each. However, this would involve extensive time and follow-up. The six test subjects used in this study preferred the natural arrangement almost unanimously. Five of the six clearly preferred the natural arrangement. The 70-year-old woman was indecisive and could not choose between the natural arrangement and the denture look. However, these patients had the benefit of evaluating multiple arrangements and could therefore identify the unacceptable tooth positions used to achieve certain concept appearances.

CONCLUSIONS

Within the limitations of this study, the following conclusions were made:

1. Survey respondents were able to differentiate between the photographs of the three denture esthetic concepts 96% of the time.
2. Survey respondents showed a 2:1:1 preference ratio for the natural compared to the supernormal and denture look.
3. Preference for a particular concept changed when responses to each test subject set were considered individually.
4. The demographic factors investigated did not affect the esthetic preference.

CLINICAL IMPLICATIONS

Completely edentulous survey respondents were able to differentiate between three esthetic concepts for complete denture construction. Guidelines for the three concepts were established and used in an attempt to standardize decision making during this phase of denture construction. Understanding of individual patient preference appears necessary because nearly half of the respondents in this survey selected arrangements that would be considered far from the anatomical average. If supported by further research, the organization of denture esthetic concepts would facilitate discussion with patients and within esthetic dentistry.

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REFERENCES

1. Chamberlain BB, Razzoog ME, Robinson E. Quality of care: compared perceptions of patient and prosthodontist. J Prosthet Dent 1984;52:744–6.
2. Bergman B, Carlsson GE. Clinical long-term study of complete denture wearers. J Prosthet Dent 1985;53:56–61.
3. Yoshizumi DT. An evaluation of factors pertinent to the success of complete denture service. J Prosthet Dent 1964;14:866–78.
4. Sheppard IM, Schwartz LR, Sheppard SM. Survey of the oral status of complete denture patients. J Prosthet Dent 1972;28:121–6.
5. Kalk W, de Baat C. Patients' complaints and satisfaction 5 years after complete denture treatment. Community Dent Oral Epidemiol 1990;18:27–31.
6. Wolff A, Gadre A, Begleiter A, et al. Correlation between patient satisfaction with complete dentures and denture quality, oral condition, and flow rate of submandibular/sublingual salivary glands. J Prosthet Dent 2003;16:4548.
7. Garrett NR, Kapur KK, Perez P. Effects of improvements of poorly fitting dentures and new dentures on patient satisfaction. J Prosthet Dent 1996;76:403–13.
8. Fenlon MR, Sherriff M. Investigation of new complete denture quality and patients' satisfaction with and use of dentures after two years. J Dent 2004;32:327–33.
9. Adell R, Lekholm U, Rockler B, Branemark PI. A 15 year study of osseointegrated implants in the treatment of the edentulous jaw. Int J Oral Surg 1981;10:387–416.
10. Zarb GA, Schmitt A. The longitudinal clinical effectiveness of osseointegrated dental implants: the Toronto study. Part II: the prosthetic results. J Prosthet Dent 1990;64:53–61.
11. Allen PF, McMillan AS. A longitudinal study of quality of life outcomes in older adults requesting implant prostheses and

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complete removable dentures. Clin Oral Implants Res 2003;14:173–9.

12. Awad MA, Lund JP, Dufresne E, Feine JS. Comparing the efficiency of mandibular implant-retained overdentures and conventional dentures among middle aged edentulous patients: satisfaction and functional assessment. Int J Prosthodont 2003;16:117–22.

13. Setz J, Kramer A, Benzing U. Complete dentures fixed on dental implants: chewing patterns and implant stress. Int J Oral Maxillofac Implants 1989;4:107–11.

14. Haraldson T, Carlsson GE. Bite force and oral function in patients with osseointegrated oral implants. Scand J Dent Res 1977;85:200–8.

15. Vallittu PK, Vallittu ASJ, Lassila VP. Dental aesthetics—a survey of attitudes in different groups of patients. J Dent 1996;24:335–8.

16. Brewer A. Selection of denture teeth for esthetics and function. J Prosthet Dent 1970;23:368–73.

17. Hirsch B, Levin B, Tiber N. Effects of patient involvement and esthetic preference on denture acceptance. J Prosthet Dent 1972;28:127–32.

18. Lefer L, Pleasure MA, Rosenthal L. A psychiatric approach to the denture patient. J Psychosom Res 1962;6:199–207.

19. Davis LG, Ashworth PD, Spriggs LS. Psychological effects of aesthetic dental treatment. J Dent 1998;26:547–54.

20. Seifert I, Langer A, Michmann J. Evaluation of psychologic factors in geriatric denture patients. J Prosthet Dent 1962;12:516–23.

21. Nairn RI, Brunello DL. The relationship of denture complaints and level of neuroticism. Dent Pract Dent Rec 1971;21:156–8.

22. Smith M. Measurement of personality traits and their relation to patient satisfaction with complete dentures. J Prosthet Dent 1976;35:492–503.

23. Silverman S, Silverman SI, Silverman B, Garfinkel L. Self-image and its relation to denture experience. J Prosthet Dent 1976;35:131–41.

24. Gordon SR, Fryer GE, Niessen L. Patient satisfaction with current dental condition related to self-concept and dental status. J Prosthet Dent 1988;59:323–7.

25. Silverman SI. The psychologic considerations in denture prosthesis. J Prosthet Dent 1958;8:582–90.

26. Friedman N, Landesman HM, Wexler M. The influence of fear, anxiety, and depression on the patient's adaptive responses to complete dentures: Part III. J Prosthet Dent 1988;59:169–73.

27. Brisman AS. Esthetics: a comparison of dentists' and patients' concepts. J Am Dent Assoc 1980;100:345–52.

28. Kokich VO Jr., Kiyak HA, Shapiro PA. Comparing the perception of dentists and lay people to altered dental esthetics. J Esthet Dent 1999;11:311–24.

29. Prahl-Anderson B, Boersma H, van der Linden FP, Moore AW. Perceptions of dentofacial morphology by laypersons, general dentists, and orthodontists. J Am Dent Assoc 1979;98:209–12.

30. Marunick MT, Chamberlain BB, Robinson CA. Denture aesthetics: an evaluation of laymen's preferences. J Oral Rehabil 1983;10:399–406.

31. Cons NC, Jenny J. Comparing perceptions of dental aesthetics in the USA with those in eleven ethnic groups. Int Dent J 1994;44:489–94.

32. Wolfart S, Brunzel S, Freitag S, Kern M. Assessment of dental appearance following changes in incisor angulation. Int J Prosthdont 2004;17:150–4.

33. Carlsson GE, Wagner IV, Odman P, et al. An international comparative multicenter study of assessment of dental appearance using computer-aided image manipulation. Int J Prosthdont 1998;11:246–54.

34. Dong JK, Jin TH, Cho HW, Oh SC. The esthetics of the smile: a review of some recent studies. Int J Prosthodont 1999;12:9–19.

35. Husley CM. An esthetic evaluation of lip-teeth relationships present in the smile. Am J Orthodont 1970;57:132–44.

36. Mohindra NK, Bulman JS. The effect of increasing vertical dimension of occlusion on facial aesthetics. Br Dent J 2002;192:164–8.

37. Owens EG, Goodacre CJ, Loh PL, et al. A multicenter interracial study of facial appearance. Part 1: a comparison of extraoral parameters. Int J Prosthodont 2002;15:273–82.

38. Miller EL, Bodden R, Jamison HC. A study of the relationship of the dental midline to the facial midline. J Prosthet Dent 1979;41:657–60.

39. Wright WH. Correlation between face form and tooth form in young adults. J Am Dent Assoc 1942;29:1388–92.

40. Brodbelt RH, Walker GF, Nelson D, Seluk LW. Comparison of face shape with tooth form. J Prosthet Dent 1984;52:588–92.

41. Sellen PN, Jagger DC, Harrison A. Computer-generated study of the correlation between tooth, face, arch forms, and palatal contour. J Prosthet Dent 1998;80:163–8.

42. Tjan AHL, Miller GD. The JGP. Some esthetic factors in a smile. J Prosthet Dent 1984;51:24–8.

43. Vig RG, Brundo GC. The kinetics of anterior tooth display. J Prosthet Dent 1978;39:502–4.

44. Cade RE. The role of mandibular anterior teeth in complete denture esthetics. J Prosthet Dent 1979;42:368–70.

45. Nassif NJ. The relationship between the mandibular incisor teeth and the lower lip. J Prosthet Dent 1970;24:483–91.

46. LaVere AM, Marcroft KR, Smith RC, Sarka RJ. Denture tooth selection: an analysis of the natural maxillary central incisor compared to the length and width of the face. Part I-II. J Prosthet Dent 1992;67:661–3,810–2.

47. Gillen RJ, Schwartz RS, Hilton TJ, Evans DB. An analysis of selected normative tooth proportions. Int J Prosthodont 1994;7:410–7.

48. Sterrett JD, Oliver T, Robinson F, et al. Width/length ratios of normal clinical crowns of the maxillary anterior dentition in man. J Clin Periodontol 1999;26:153–7.

49. Goodkind RJ, Schwabacher WB. Use of a fiber-optic colorimeter for in vivo color measurements of 2830 anterior teeth. J Prosthet Dent 1987;58:535–42.

50. Young L Jr., Glaros AG, Moore DJ, Collins JF. Assessing shade differences in acrylic resin denture and natural teeth. J Prosthet Dent 1994;71:575–80.

51. Jahangiri L, Reinhardt SB, Mehra RV, Matheson PB. Relationship between tooth shade value and skin color: an observational study. J Prosthet Dent 2002;87:149–52.

52. Profitt WR, Fields HW. Contemporary orthodontics. 3rd ed. St. Louis (MO): CV Mosby; 2000, p.145–293.

53. Sears VH. Selection of anterior teeth for artificial dentures. J Am Dent Assoc 1941;28:928–35.

54. Berkey DB, Call RL, Loupe MJ. Oral health perceptions and self-esteem in non-institutionalized older adults. Gerodontics 1985;1:213–6.

55. Matthias RE, Atchison KA, Schweitzer S, et al. Comparisons between dentist ratings and self-ratings of dental appearance in an elderly population. Spec Care Dent 1993;13:53–60.

56. The Academy of Prosthodontics. Principles, concepts, and practices in prosthodontics—1994. J Prosthet Dent 1995;73:73–94.

57. Frush JP, Fisher RD. Introduction to dentogenic restorations. J Prosthet Dent 1955;5:586–95.

58. Frush JP, Fisher RD. How dentogenic restorations interpret the sex factor. J Prosthet Dent 1956;6:160–72.

59. Frush JP, Fisher RD. How dentogenics interprets the personality factor. J Prosthet Dent 1956;6:441–9.

60. Frush JP, Fisher RD. The age factor in dentogenics. J Prosthet Dent 1957;7:5–13.

61. Frush JP, Fisher RD. The dynesthetic interpretation of the dentogenic concept. J Prosthet Dent 1958;8:558–81.

62. Frush JP, Fisher RD. Dentogenics: its practical application. J Prosthet Dent 1959;9:914–21.

63. Shor A, Shor K, Goto Y. The edentulous patient and body image—achieving greater patient satisfaction. Pract Proced Aesthet Dent 2005;17:289–96.

64. Ament P, Ament A. Body image in dentistry. J Prosthet Dent 1970;24:362–6.

65. Lombardi RE. The principles of visual perception and their clinical application to denture esthetics. J Prosthet Dent 1973;29:358–82.

66. Brigante RF. Patient-assisted esthetics. J Prosthet Dent 1981;46:14–20.

67. Zarb GA, Bolender CL, Carlsson GE. Boucher's prosthodontic treatment for edentulous patients. 11th ed. St. Louis (MO): CV Mosby; 1997, p. 231–331.

68. Vig RG. The denture look. J Prosthet Dent 1961;11:9–15.

69. Lombardi RE. A method for the classification of errors in dental esthetics. J Prosthet Dent 1974;32:501–13.

70. Lombardi RE. Factors mediating against excellence in dental esthetics. J Prosthet Dent 1977;38:243–8.

71. Curtis TA, Shaw EL, Curtis DA. The influence of removable prosthodontic procedures and concepts on the esthetics of complete dentures. J Prosthet Dent 1987;57:315–23.

72. Tautin FS. Denture esthetics is more than tooth selection. J Prosthet Dent 1978;40:127–30.

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