

ESTHETIC PERCEPTIONS OF DIFFERENT ORTHODONTIC TREATMENT  
MODALITIES AMONG AMERICAN ADULTS

A Thesis

By

DAVID LUKE CHASTAIN

Submitted to the Graduate and Professional School of  
Texas A&M University  
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

Chair of Committee,  
Committee Members,  
Head of Department,

Peter H. Buschang  
Matthew Kesterke  
Gayle Glenn  
Madhu K. Nair

May 2022

Major Subject: Oral Biology

Copyright 2022 David Luke Chastain

## ABSTRACT

Introduction: The aim of this study was to assess the esthetic perceptions of orthodontic treatment modalities among American adults.

Methods: 539 adults were surveyed. Survey participants were asked to evaluate photographs of a model's teeth with 7 different situations: no orthodontic appliances, full mouth metal brackets with blue o-rings, full mouth metal brackets with grey o-rings, full mouth ceramic brackets with clear o-rings, clear aligners with attachments on all maxillary teeth, clear aligners with attachments on all maxillary teeth except the central incisors, and clear aligners with no attachments. Survey respondents were asked to rate the different treatment modalities on a Visual Analog Scale (VAS) from 0-100 with "very unattractive" and "very attractive" as anchors. They were also asked to rank the orthodontic treatment modalities in rank-order and select the single appliance they would most prefer to be treated with.

Results: No appliance on the teeth scored the highest median (94), followed by clear aligners with no attachments (80). Next, there were three appliances with median scores showing no statistically significant differences between each other: clear aligners with attachments everywhere (62), clear aligners with attachments everywhere except the U1s (60), and clear braces (59). Metal braces with blue and grey o-rings had the lowest median scores (50, 50).

Conclusion: Clear aligners with no attachments are the most esthetic option among American adults. However, when attachments are added to the clear aligners, clear braces are found to be equally esthetic. Metallic braces are the least esthetic treatment modality.

## ACKNOWLEDGMENTS

I'd like to thank my committee members Drs. Peter Buschang, Matthew Kesterke, and Gayle Glenn for their support and guidance throughout this endeavor. Their knowledge and experience were instrumental in completing this project.

I would like to acknowledge the Texas A&M College of Dentistry orthodontic residency class of 2022: Drs. Kyle Kuzmic, Daniel Dooley, Abbey Janssen, Cameron Keylor, and Kativa Strickland. It was an honor to be surrounded by the most intelligent and driven people I've ever known for the last 3 years, and I could not have asked for better co-residents.

To my parents Kirk and Genetha Chastain, thank you for always sacrificing your needs to put my mine first. You have paved the way for my life and given me the perfect example of how to be a good parent to my children.

Finally, thank you to my wife, Melissa Chastain. You are the most incredible woman, mother, wife, sister, and daughter that I know. I am so lucky to have you as my partner for the rest of our lives, and I cannot wait to finish up this chapter of our lives and raise our beautiful family together.

## CONTRIBUTORS AND FUNDING SOURCES

### **Contributors**

This work was supported by a thesis committee consisting of Drs. Peter Buschang, Matthew Kesterke, and Gayle Glenn of the Department of Graduate Orthodontics at Texas A&M College of Dentistry.

All work for the thesis was completed by the student, under the advisement and with assistance of the committee members.

### **Funding Sources**

This work was made possible by Texas A&M University for funding and equipment.

## TABLE OF CONTENTS

	Page
ABSTRACT.....	ii
ACKNOWLEDGMENTS.....	iii
CONTRIBUTORS.....	iv
TABLE OF CONTENTS.....	v
LIST OF FIGURES.....	vi
LIST OF TABLES.....	vii
LITERATURE REVIEW.....	1
Conventional brackets.....	1
Clear brackets.....	3
Clear aligners.....	4
Psychological basis of perception.....	7
Esthetics of orthodontic appliances.....	9
Summary.....	11
MATERIALS AND METHODS.....	12
Appliance fabrication and placement.....	12
Photographs.....	13
Survey and distribution.....	13
Statistics.....	14
RESULTS.....	15

DISCUSSION.....	18
CONCLUSIONS.....	24
BIBLIOGRAPHY.....	25
APPENDIX A FIGURES.....	30
APPENDIX B TABLES.....	40

### LIST OF FIGURES

	Page
Figure 1 Images of the model with each orthodontic appliance on her teeth .....	30
Figure 2 Introductory questions from survey.....	31
Figure 3 Respondents asked to assign a VAS value to each image individually.....	31
Figure 4 Rank order – participants were asked to rank the images from most esthetic to least esthetic.....	32
Figure 5 Survey questions.....	33
Figure 6 Descriptive statistics: gender.....	33
Figure 7 Descriptive statistics: age groups.....	34
Figure 8 Descriptive statistics: history of orthodontic treatment .....	34
Figure 9 Descriptive statistics: history of dental education .....	35
Figure 10 Median values assigned to each orthodontic treatment modality .....	35
Figure 11 Results of rank-order.....	36
Figure 12 How much longer would participants be willing to be in treatment if it meant they were treated with the more esthetic option?.....	36
Figure 13 When given the choice, which orthodontic appliance would participants most prefer to be treated with?.....	37
Figure 14 Median values assigned to each orthodontic treatment modality	

	when filtered by age group.....	37
Figure 15	Median scores of orthodontic treatment modalities among those with and without a history of orthodontic treatment.....	38
Figure 16	Median scores of orthodontic treatment modalities among those with and without a history of dental education.....	38
Figure 17	Median scores of orthodontic treatment modalities among gender.....	39

### LIST OF TABLES

Table 1	Descriptive statistics: gender .....	40
Table 2	Descriptive statistics: age groups .....	40
Table 3	Descriptive statistics: history of orthodontic treatment.....	41
Table 4	Descriptive statistics: history of dental education .....	41
Table 5	Median values assigned to each orthodontic treatment modality .....	41

## I. LITERATURE REVIEW

Orthodontics has always been primarily focused on children and adolescents. However, a survey conducted by the American Association of Orthodontists (AAO) in 2018 revealed that 33 percent of US and Canadian patients were adults<sup>1</sup>. This large percentage of adult patients can likely be attributed to an increase in education and advertising, along with the advent of new orthodontic appliances that can treat patients more discreetly. However, this supposition has not been tested. With a third of the population being adults, it is imperative to understand what goes into their treatment preferences. To determine what adults prefer in terms of orthodontic treatment modalities, it is first important to understand what options are available to them and the background of these appliances. After understanding what options are available for orthodontic treatment, it is necessary to review the literature to understand how patients ultimately decide on one treatment modality over another. Adult patients demand a more esthetic option for their orthodontic appliances, and the present study will aim to evaluate some of these options and determine adults' preferences.

### Conventional Brackets

Originally, brackets were welded onto bands and bands were placed on each tooth. This caused increased discomfort for the patient and increased time for the orthodontist, as spaces had to be made prior to band placement and closed following band removal. In the 1960s, George Newman came up with the ability to bond brackets directly to the enamel<sup>2</sup>. Although bonding directly to the enamel surface has greatly improved in recent years, in 1982 Mizrahi<sup>3</sup> found that failure rate on posterior teeth is much lower with banded orthodontic appliances while failure rate on anterior teeth is much lower with bonded orthodontic appliances. Rapid improvements in the ability to bond directly to the enamel resulted in a shift from banded brackets to bonded



brackets almost universally. This was one of the first movements to a smaller, less obvious orthodontic appliance. Wang et al<sup>4</sup> in 2004 found that different bracket base designs can offer varying amounts of bond strength. The bracket base consisted of designs that had welded and cast bases with varying sizes and designs of mesh. Some brackets had double mesh while others had circular concave designs or a simple retention groove. They found that the larger the base, the greater the bond strength. Further, the larger the mesh spacing, the greater the bond strength as it allowed the composite to get into the mesh and cure in the undercuts. Finally, the larger mesh sizes correlated with a greater bond strength. In 2001, Douglas et al<sup>5</sup> looked at the bond strengths of three adhesives: a composite resin, hybrid glass ionomer cement, and glass filled glass ionomer cement. They found that all three adhesives gave clinically acceptable shear bond strengths, but the composite resin, (Transbond XT) provided the greatest shear bond strength. It is a delicate balance of finding a bond strength that is strong enough to prevent failure rates but not so strong that you get enamel fracture upon debond. Douglas, et al found that the adhesives with the largest bond strengths also have the greatest frequencies of enamel fracture. A systematic review in 2018 evaluated orthodontic adhesives in detail<sup>6</sup>. It showed that there was no statistically significant difference between light cured composite and chemically cured composite. They also found that chemically cured glass ionomer cement had higher failure rates when compared to chemically cured composite cement. Only one study in their systematic review compared chemically cured composite to chemically cured compomer, and it reported no statistically significant difference in bond strength, leading them to conclude that compomers could serve as a viable option in orthodontic bonding.

## Clear Brackets

As technology continued to advance in the field of orthodontic appliances, patients wanted a more esthetic option. This led dental manufacturers and companies to develop clear braces. The first clear brackets were made from plastic, and some of the earliest plastic brackets were made from acryl and then polycarbonate. However, these plastic brackets had many problems such as poor bond strength, permanent deformation of the wings, and discoloration<sup>7</sup>. Attempts were made to reinforce these plastic brackets by blending ceramic and fiberglass into the polycarbonate. Metal slots were also incorporated to help mitigate the creep and deformation that occurs with plastic brackets. Matsui et al found that the strain of wings in plastic brackets is 0.2% and the strain in ceramic and metal brackets is negligible<sup>7</sup>. Feldner et al<sup>8</sup> found a torque loss of 15% due to creep in polycarbonate brackets. Although these brackets are esthetically pleasing, dental manufacturers continued to search for an esthetic option that provided more stability with less strain and displacement of the brackets.

This led to the development of ceramic brackets. Matsui et al looked into the mechanical properties of ceramic brackets and found that, in general, ceramic brackets overcame the shortcoming of plastic brackets. They have much stronger rigidity and abrasion resistance while remaining free from coloration. Despite this strength and rigidity of the bracket itself, there are problems associated with ceramic brackets, most of which have to do with the debonding procedure. Initially ceramic brackets were bonded using a silane coupling agent that frequently resulted in enamel fractures. Instead of being able to plastically deform like plastic or metal brackets when debonding, the ceramic bracket simply breaks and leaves behind fragments that make complete debonding more difficult. Mechanical engagement of the bracket base and the introduction of weak points in the center of the ceramic brackets have improved debonding in

recent years. Suliman et al<sup>9</sup> attempted to find quantitative data to support the claim that debonding with ceramic brackets has become safer for the enamel. They found that both polycrystalline and monocrystalline brackets can be debonded with minimal to no enamel damage, with polycrystalline brackets resulting in slightly more enamel loss following bracket and adhesive cleanup. Ceramic brackets are associated with a higher surface roughness which translates to a higher frictional resistance. Increased frictional resistance can adversely affect clinical outcomes, particularly during space closure. Bracket manufacturers have added metal to the slot surfaces to help decrease their frictional resistance. Along with the debonding risks of ceramic brackets, abrasion of enamel can occur at a rapid rate if the ceramic bracket contacts opposing teeth. Monocrystalline brackets have shown the highest abrasion scores<sup>10</sup>. Due to the technological advances in orthodontic materials and esthetic demands of patients, ceramic brackets have become a viable treatment option.

### Clear Aligners

Brackets have been the gold standard for treating orthodontic patients for many years, whether it be with metal, ceramic, or even plastic brackets. However, the innovation of clear aligner therapy has recently taken the orthodontic community by storm. Most major dental supply companies now offer their own version of clear aligner therapy (3M, Ormco, Align, Dentsply Sirona) along with the plethora of do-it-yourself aligner companies that ship aligners straight to the customer's door. Needless to say, clear aligner therapy is here to stay, and as such, it is important to evaluate how the technology has advanced and the efficacy of clear aligner treatment modalities. Removable thermoplastic tooth positioners were first introduced by Kesling<sup>11</sup> in 1946 when he used them to reposition misaligned teeth. TP Orthodontics has been using this tooth positioner ever since. Although a form of clear aligner therapy has been in use

since the 1940s, it was not until the end of the last century that aligners were used for more than minimal tooth movements. In 1998 the FDA gave approval to Align to begin using Invisalign for orthodontic purposes. Since then, clear aligner therapy has improved its technology and become more and more efficient at treating patients.

When looking at the efficacy of clear aligner treatment, it is helpful to look at how it compares to conventional edgewise brackets. In 2014, Buschang et al compared treatment time of clear aligners to conventional edgewise brackets<sup>12</sup>. They found that clear aligner treatment required fewer appointment visits (4 fewer), shorter treatment time (5 months), and less chair time. However, the material cost/overhead and doctor time were significantly more for clear aligner therapy treatment than for the conventional bracket group. In 2007, Miller et al evaluated the differences in quality of life of patients treated with clear aligner treatment compared to those who were treated with fixed aligners during the first week of treatment<sup>13</sup>. They performed a prospective, longitudinal cohort study that had the subjects keep a daily diary recording treatment effects on function, psycho-social, and pain-related outcomes. The results showed that both the clear aligners and the fixed appliances decreased quality of life during the first week. However, their results showed that the fixed appliance group experienced a greater decrease in quality of life and greater pain when compared to the clear aligner group. White et al corroborated these claims with similar findings in 2017<sup>14</sup>. Further, Buschang et al found that patients treated with traditional fixed appliances are at higher risk of white spot lesions when compared to clear aligner therapy<sup>15</sup>. When looking at these advantages of clear aligners, it is clear why patients might prefer this treatment modality over traditional fixed appliances. It is also important to consider how clear aligners match up to traditional fixed appliances in terms of treatment outcomes. A systematic review found that clear aligner therapy is effective at

leveling/aligning and achieving anterior intrusion, but not effective at anterior extrusion<sup>16</sup>. Aligners are effective at controlling posterior buccolingual inclination but not at controlling anterior buccolingual inclination<sup>16</sup>. This same systematic review noted to use caution when applying these results due to the lack of quantity and quality of existing studies on the topic. A study in 2014 evaluated end of treatment occlusion compared with the predicted final occlusion<sup>17</sup>. This was done by taking the initial ClinCheck and final occlusion models and measuring them according to the American Board of Orthodontics Objective Grading System (OGS). The study found that the ClinCheck does not accurately reflect the final occlusion immediately after treatment. They also found that the ClinCheck overestimated alignment, buccolingual inclinations, occlusal contacts, and occlusal relations. A systematic review in 2020 concluded that treatment with clear aligners results in more unacceptable outcomes and worse occlusal outcomes resulting in lower OGS scores when compared to traditional fixed brackets<sup>18</sup>. They determined that treatment with clear aligners is not as effective as treatment with fixed appliances. In 2017, Weir summarized the use of clear aligners in orthodontic treatment based on a review of the literature<sup>19</sup>. A chart outlining the tooth movement predictability was developed. He determined that the more mild the malocclusion, the more effectively and predictable clear aligners can treat the case. As the cases become more severe and difficult, the aligners are less able to produce a good outcome<sup>19</sup>.

To try and improve on clear aligner effectiveness, manufacturers and orthodontists started putting composite attachments on the teeth to allow the plastic to have undercuts to aid in retention when applying stronger forces. In 2015 Dasy et al examined the effects of different attachment shapes on aligner retention<sup>20</sup>. Their results showed that ellipsoid attachments provided minimal additional retention to the aligners while beveled attachments provided a

significant increase in retention. Along with increased retention, it has been claimed that different types of attachments can help increase the efficiency of certain types of tooth movements<sup>21</sup>. Kravitz et al looked at how vertical ellipsoid attachments and interproximal reduction (IPR) influence the rotation of mandibular canines. They found that the vertical ellipsoid attachments did not increase the efficiency of rotating mandibular canines. Simon et al looked at three different types of tooth movements performed by clear aligners: upper incisor torque greater than 10 degrees, premolar derotation greater than ten degrees, and molar distalization greater than 1.5mm. They found that all 3 movements can be performed with or without attachments, but they do not get full expression of the movements as is seen in the ClinCheck. Starting in 2008, however, Invisalign released their SmartForce features which include optimized attachments, pressure zones, and customized staging which they claim increase tooth movement efficiency. As attachments have become more and more of a staple in clear aligner therapy, more studies need to be done looking at their effect on the biomechanics of tooth movement and their effect on the esthetic perception of the patient.

### Psychological Basis of Perception

Now that the pros and cons of different esthetic treatment modalities have been reviewed, it is necessary to evaluate the psychological basis for humans having specific preferences. In 2017, Felin et al attempted to explore how our sense of sight and rationality play a role in perception<sup>22</sup>. This paper takes a look at how our sense of sight plays a central role in prominent theories of rationality. Most thoughts on perception are based on bias, boundedness, and blindness. This basically means that the way we interpret what we encounter is influenced by inherent biases and preferences that have been molded throughout our lifetime. We attempt to rationalize what we take in through our sense of sight and make sense of it logically, but it is hard do so without a

bias due to our past experiences. Hoffman et al attempted to provide a theory in explaining the current view of perception. In the early 1860s Fechner asked what the relationship was between perception and reality. Since then, a consensus among scientists has determined that with vision, what we see is what we get. Hoffman et al wanted to see if we are accurately able to describe with appropriate language what we see with our eyes. If so, this would provide a more definitive answer of perception, as we would be able to comprehensively and fully describe what our sense of vision sees<sup>23</sup>. They postulated that our words are not adequate to explain what we see, therefore perception does not perfectly equal reality. They argue that the interface theory of perception is the most accurate. This theory states that the relationship between our perceptions and reality is similar to a desktop interface and a computer. However, with perception there is sometimes a disparity between reality and what is perceived. An example of this is commonly referred to as #TheDress, which was a cultural phenomenon where some people perceive a dress as white and gold while others perceive the dress as black and blue. Color illusions are often different colors that are perceived as the same color because the brain is “fooled”. With #TheDress, it is different because there is bimodal distribution in the colors that are actually perceived. The primary theory behind this is that the first encounter the subject has with #TheDress strongly determines how it is perceived in the future. It acts as a one-shot learning, imprinting mechanism that biases the subject for future encounters. This is demonstrated by Drissi-Daouidi et al when subjects wore occluders to hide large parts of the background of the dress. With white occluders, subjects saw a black and blue dress. With black occluders, subjects saw a white and gold dress. The percept for these subjects did not change when occluders were removed<sup>24</sup>. How humans perceive things is multifactorial in nature and researchers have

performed numerous studies to try and understand this concept. Although perception often means what we see is reality, sometimes our perception is skewed by our biases.

### Esthetics of Orthodontic Appliances

With all of the advances in orthodontic appliances, patients now have the option to choose from a broad array of treatment modalities. When patients are making these decisions, they weigh in multiple factors such as esthetics, cost, treatment outcome, and length of treatment. A study in 2003 by Meier et al looked at the patient profile of prospective patients wanting Invisalign treatment. They found that mainly women aged 20-29 years old were interested in Invisalign. They were primarily interested in the esthetics of the appliance and were willing to accept treatment time of 1.5-2.5 years. Rosvall et al had a study that was one of the first to look at the esthetics of different orthodontic appliances. They provided photographs of a patient with variations of stainless steel, ceramic, and plastic appliances. The study chose a standard stainless steel twin bracket of average size because Ziuchkovski et al proved that the size of the bracket does not influence esthetic perception among patients. The study had each participant assign a value to orthodontic appliance on a Visual Analog Scale ranging from “extremely unattractive” to “extremely attractive”. The study showed that the order of most attractive to least attractive orthodontic appliances was: clear aligners/lingual brackets > ceramic appliances > then stainless steel appliances<sup>25</sup>. The clear aligner options did not include composite attachments which are frequently utilized in today’s clear aligner patients. Ziuchkovski et al performed a similar study and found the same results. They also determined that orthodontic appliance attractiveness does not vary between brands and there is minimal clinically significant difference in attractiveness between different demographic factors<sup>26</sup>. In 2012, Feu et al performed a study that looked at the esthetic perception of orthodontic appliances by Brazilian adults. The study had pictures of clear



braces, metal braces with and without colored o-rings, and clear aligners. The clear aligners in this study had one set of photos with attachments on all the teeth except the centrals and a set of photos with clear aligners and no attachments. There was not a set of photographs of clear aligners with attachments on all the maxillary anterior teeth. Their results showed that clear aligners with no attachments were the most esthetic, and clear brackets with an esthetic archwire were second best in the age group of 27 years old and up. Clear aligners with attachments were next followed by clear brackets with a normal archwire and finally stainless steel brackets<sup>27</sup>. This was one of the first studies that looked at the esthetics of clear aligners with attachments. The most recent study looking at the esthetics of orthodontic appliances was published by Thai et al in 2020. This study was unique in that it assessed the esthetic perception of orthodontic appliances and clear aligner attachments in particular using eye-tracking technology<sup>28</sup>. They used Tobii Lab Pro eye tracking software to assess how long the eyes stayed fixated on each area of the mouth and smile. They also placed the 4 different appliances (clear braces, clear aligners with minimal attachments, clear aligners with posterior attachments, and clear aligners with anterior and posterior attachments) in order from most esthetic to least esthetic. They did not have a VAS to quantify their ranking of esthetic perceptions. Their results showed that participants spent the least amount of time fixated on the clear aligners with minimal attachments followed by clear braces, posterior attachments, then posterior and anterior attachments. This mirrors the esthetic preferences according to the participants' rank order responses. Their results also showed that more people chose ceramic brackets (44% of participants) as their most preferred option over clear aligners with minimal attachments (42% of participants). When asked why they preferred the ceramic brackets over the aligners, they claimed that they looked "intentional, symmetric, and clean" compared to the clear aligners with attachments.

## Summary

As demonstrated in this review of existing literature, esthetic perception of orthodontic appliances is an important aspect to consider when deciding treatment modalities. Today's patient pool is including more and more adults and these adults demand a more esthetic treatment option. Although beauty is in the eye of the beholder, studies have been conducted to try and quantify these esthetic preferences. To date, no studies have looked at the esthetic perceptions of orthodontic appliances that include attachments on all the teeth compared to only some of the teeth and used a visual analog scale to assess this. Our study looks to build on existing literature and help practitioners make more informed decisions when presenting treatment options to their patients.

## II. MATERIALS AND METHODS

### Appliance Fabrication and Placement

The study was deemed exempt from TAMU IRB (IRB2020-1374-CD-EXM). To evaluate esthetic preferences, one adult volunteer was selected to serve as the model for the orthodontic appliances. The volunteer signed an informed consent acknowledging that the photographs of her mouth would be used for the study. The selection criteria for the volunteer were as follows: well aligned teeth, adequate incisal and gingival display upon smiling, and no gross staining present on teeth. Seven different situations were photographed: no orthodontic appliances, full mouth metal brackets with blue o-rings, full mouth metal brackets with grey o-rings, full mouth ceramic brackets with clear o-rings, clear aligners with attachments on all maxillary teeth, clear aligners with attachments on all maxillary teeth except the central incisors, and clear aligners with no attachments (Figure 1).

The brackets bonded were 3M Victory Series and 3M Clarity Advanced Ceramic brackets. They were bonded in an ideal location at the facial axis point with Transbond XT. Neither etchant nor primer were used to allow for easy clean up and removal. Brackets were bonded on the teeth from maxillary 2<sup>nd</sup> molar to 2<sup>nd</sup> molar. The lower teeth were not bonded because they are not visible while smiling. During placement, a 17x25 SS archwire was placed in the bracket slots to allow standardized bracket placement and reproducibility.

The clear aligners were fabricated using casts of the volunteer's teeth. Three different sets of aligners were produced, with the first set of aligners having no attachments on any of the teeth. The aligners were scalloped at the gingival border. The next set of aligners were produced to simulate composite attachments on the volunteer's teeth. Attachments were placed on all the

maxillary teeth except the central incisors. Finally, a set of clear aligners were fabricated with composite attachments on the facial surfaces of all the maxillary teeth. The protocol for these attachments was similar to the placement of brackets, in that no acid etching or priming was performed.

### Photographs

Following placement of each orthodontic treatment modality, photographs were captured using manual settings. The camera used was a Canon T7i with a ring flash. The F stop was set on 32 and the ISO was 100. The volunteer was placed in natural head position and a reproducible smile was captured from a standardized distance of 100cm. The photographs were then randomly labeled A through F for use in the survey (Figure 1).

### Survey and Distribution

The survey was created (Figure 2) using Qualtrics (Qualtrics, Provo, UT) software and then distributed to students within the Texas A&M University system, including both undergraduate students, graduate, and professional students. To be eligible for the survey, participants had to be 18 years of age or older. The participants were asked if they previously had orthodontic treatment, and if so, what kind of treatment they had (traditional metal braces or clear aligners). Participants were also asked their age, gender, and if they had any history of dental education.

Each participant in the survey was asked to rate the images of the volunteer's smile with various orthodontic appliances on her teeth. There was a total of 637 respondents to the survey. However, due to drop outs and incomplete survey responses, the answers of 539 respondents were analyzed. For example, if participants did not assign a value to all the images, their responses were not included in the analysis. Further, they were eliminated if they did not specify

whether they had orthodontic treatment in the past to avoid a potential bias in their response. Survey respondents were asked to rate the different treatment modalities on a Visual Analog Scale (VAS) from 0-100 with “very unattractive” and “very attractive” as anchors (Figure 3). After the participants individually rated each image, they were then showed a composite of all treatment modalities and asked to rank the images from most attractive to least attractive (Figure 4). This was done to give a form of intra-respondent reliability. Participants were then asked how much more they would be willing to spend to be treated with the most esthetic treatment option with answer choices ranging from \$0-\$2,000 (Figure 5). Finally, participants were asked how much longer they would be willing to spend in treatment to be treated with the more esthetic option.

#### Statistical Analysis

The skewness and kurtosis statistics were used to evaluate the normality of the distributions. Because the data were not normally distributed, non-parametric statistics were used. All statistics were run using SPSS (IBM SPSS Statistics for Windows, Version 24.0 Armonk, NY) software. The Mann Whitney and Kruskal-Wallis tests were used with 0.05 determining statistical significance before Bonferroni corrections.

### III. RESULTS

Descriptive statistics of the 539 respondents can be found in (Tables 1-4). 73% of survey respondents were female and 27% of the respondents were male (Figure 6). The majority of survey respondents were in the 18-25 age group at 67.9% (366), followed by 14.8% (80) in the 45+ age group, 11.1% (60) in the 26-35 age group, and finally 6.1% (33) in the 36-45 age group (Figure 7). When participants were asked about previous history of orthodontic treatment (Figure 8), 64.2% (346) stated they previously had traditional metal braces, 28.2% (152) stated they never had orthodontic treatment, and 7.6% (41) stated they previously had clear aligner therapy. 89.8% (484) had no history of dental education while 10.2% (55) did (Figure 9).

No appliance on the teeth scored the highest, with a median score of 94 (Figure 10, which denotes statistically significant between-appliance differences using symbols). This was followed by clear aligners with no attachments, which had a significantly lower median score of 80. There were three appliances with median scores showing no statistically significant differences between each other: clear aligners with attachments everywhere (62), clear aligners with attachments everywhere except the U1s (60), and clear braces (59). Metal braces with blue and grey o-rings had the lowest median scores (50). Table 5 provides the medians and interquartile ranges for each orthodontic appliance.

When participants were asked to rank the treatment modalities, clear aligners with no attachments (F) were chosen as the most esthetic appliance (Figure 11). Clear aligners with no attachments were followed by clear aligners with attachments everywhere (B) and clear aligners with attachments on all teeth except the U1s (D), which were similarly ranked. Clear braces (E) were ranked next most esthetic followed by both sets of metal braces (A & C), which came ranked similarly.

When asked how much longer the participants would be willing to be in treatment if it meant they got to use the more esthetic option, 42% said they would accept being in treatment up to 6 months longer, 26% indicated 1 year longer, and 5% indicated 2 years longer (Figure 12). 27% said they would not accept any longer treatment. Respondents indicated that they were willing to pay a median of \$607 more for the most esthetic option that they chose. When asked to identify the one appliance they would prefer the most to be treated with, the vast majority selected clear aligners with no attachments (Figure 13). Somewhat surprising, the clear brackets were the next most selected followed by metal brackets with light blue o-rings. This is represented by Figure 13 in Appendix A.

There were statistically significant age differences for four of the appliances (Figure 14). The 18-25 year old participants found the no appliance less esthetic than the other age groups. However, the only statistically significant differences were found between the 18-25 year old group and the 45+ year old group. Similarly, the 18-25 year old respondents noted that all 3 clear aligner groups were significantly less esthetic than the 45+ year old group.

There were statistically significant differences among the respondents who did and did not previously undergo orthodontic treatment (Figure 15). The respondents who previously had clear aligner treatment rated clear aligners as more esthetic than those who did not previously undergo clear aligner therapy or had traditional braces. Specifically, those with a history of clear aligner therapy gave a median score of 84 to clear aligners with no attachments and a score of 72 to clear aligners with any attachments present. Conversely, those without a history of clear aligner treatment gave a median score of 80 to clear aligners with no attachments and a median score of 60 to clear aligners with any attachments present.

There were no statistically significant between-group differences between respondents who did and did not have a history of dental education (Figure 16). Further, there were no statistically significant gender differences except for the image with no appliance, which females rated as slightly more esthetic (Figure 17).



#### IV. DISCUSSION

Aligners with no attachments present on any teeth are most preferred among American adults. The present study revealed that when it comes to esthetic preferences, clear aligners with no attachments had significantly higher VAS scores than all other treatment modalities. Further, when survey participants were asked to place all treatment modalities in rank order from most esthetic to least esthetic, the clear aligners with no attachments were ranked #1 the most number of times. Finally, when participants were asked which treatment modality they would most prefer to be treated with, clear aligners with no attachments were selected the most number of times. The existing literature supports the present study's findings. Feu et al found that clear aligners with no attachments were the most esthetic among both males and females and all age groups<sup>27</sup>. A study in 2020 used eye-tracking technology to evaluate what orthodontic treatment modalities American adults find most esthetic<sup>28</sup>. Although their methodology differed from existing literature, they found that participants spent the least time on the clear aligner group with minimal attachments which indicates they find them the most esthetic. Two other studies found that clear tray appliances and lingual appliances were the most esthetic orthodontic appliances in American adults<sup>25,26</sup>. These findings are to be expected as clear aligners with no attachments are the most discreet treatment modality and most closely resemble natural teeth. However, very few orthodontic practitioners treat comprehensive orthodontic patients with no attachments present on any teeth. Outside of direct to consumer aligner companies, this treatment modality is rarely used outside of clear essix retainers.

American adults consider clear aligners with attachments covering all or most of the maxillary teeth to be no more esthetic than clear brackets. The present study showed no differences in median VAS scores between clear aligners with attachments on all maxillary teeth

(62), clear aligners with attachments on all maxillary teeth except the central incisors (60), and clear braces (59). Interestingly, the median scores of clear aligners with attachments (60 and 62) were much closer to metal braces (50) than clear aligners with no attachments (80). This is indicative of adults wanting a treatment modality that does not have any appliance, whether it be clear brackets or composite attachments, attached on the buccal surfaces of teeth. When looking at how respondents ranked the various appliances, this is the only place we find contradictory results. Respondents ranked clear aligners with no attachments 1<sup>st</sup> on average, followed by the two aligners groups with attachments ranked 3<sup>rd</sup> on average. Clear braces were ranked 4<sup>th</sup> on average with both sets of metal braces being ranked 5<sup>th</sup> on average. Although there were no statistically significant differences according to the VAS, and respondents actually chose clear braces as their #1 choice more than clear aligners with attachments, clear braces fell behind clear aligners with attachments when it came to rank order. There are limited studies evaluating clear aligners with attachments present on the anterior teeth. Feu et al performed a similar study on Brazilian adults, however, their study included attachments only on the lateral incisors and canines<sup>27</sup>. Their results showed that clear aligners with no attachments were the most esthetic, followed by clear brackets and clear aligners with attachments on the lateral incisors and canines. They found no statistically significant differences between aligners with anterior attachments and clear (sapphire) braces. Using eye-tracking technology to determine esthetic preferences among American adults, Thai et al found that clear aligners with no attachments were the most esthetic followed by clear, ceramic braces, then clear aligners with posterior attachments, and finally clear aligners with attachments on all maxillary teeth to be the least esthetic<sup>28</sup>. This conclusion further bolsters the notion that clear aligners with attachments present on all maxillary teeth are no more esthetic than clear braces. In 2010, Jeremiah et al looked at the esthetics of various

orthodontic appliances among UK residents. They did not look at anterior attachments on the teeth, a marked difference from the present study. Their aligners had no attachments present on the teeth, but they still showed similar results with the clear aligner group being most preferred<sup>29</sup>. As clear aligner technology has advanced, so has the use of attachments on the teeth. When composite attachments are present on most or all maxillary teeth, they lose the advantage of being inconspicuous to onlookers. This is likely due to the uniformity of clear brackets and people being familiar with braces. When respondents see clear braces, they see a more esthetic version of metallic braces. Conversely, when respondents see clear aligners with composite attachments present on maxillary teeth, they see a less esthetic version of clear aligners with no attachments. This contrast likely contributes to the differences seen in the present study along with previous studies.

Metal braces are less esthetic than aligners and clear braces, regardless of o-ring color. The median VAS scores assigned to metal braces in the present study were significantly lower than all other treatment modalities. Furthermore, when survey respondents were asked to arrange their preferences in rank-order, the metal braces were the least preferred. When the participants in the present study were asked which treatment modality they most preferred, metal braces with grey o-rings were chosen the least number of times. These findings are consistent with existing literature. Feu et al also found that metal brackets were considered to be the least esthetic among eight treatment modalities, with no differences between the type of metal bracket (self-ligating, traditional twin, golden metal)<sup>27</sup>. Others have shown that stainless steel metallic brackets were less preferred than clear aligners and clear ceramic brackets<sup>25,26</sup>. Traditional stainless steel brackets are what most orthodontic patients were treated with for the last few decades. Although metal brackets are the most commonly used modality among adolescents, adults find metallic

brackets the least esthetic treatment modality. As a result, it is important to understand the hierarchy of esthetic preferences when presenting treatment options to the patient which is: no appliance present > clear aligners with no attachments > clear aligners with attachments/clear braces > metallic braces.

Adult orthodontic patients previously treated with clear aligners find any treatment modality involving clear aligners to be more esthetic. The present study showed that there were statistically significant differences in median VAS scores between those previously treated with aligners and those that had not been treated with aligners. Respondents previously treated with aligners gave a median score of 72 to aligners with any form of attachments while the groups not previously treated with aligners gave a median score of 60. Further, the group with a history of clear aligner treatment gave a median score of 84 to clear aligners with no attachments while those that did not have a history of clear aligner treatment gave median scores of 80, which was a statistically significant difference. There were no statistically significant differences among any of the other treatment modalities when considering history of orthodontic treatment. To date, there is no existing literature that specifically looked at history of clear aligner therapy so there can be no comparisons made about the present study's findings. Ziuchkovski et al looked at history of previous orthodontic treatment, however they did not discern whether they were treated with metal braces or clear aligners<sup>26</sup>. Thus, we cannot reliably translate these findings to the present study. These findings indicate a bias among those who have already been treated with clear aligners. This bias is likely due to their familiarity with the treatment modality. They are less familiar with the other treatment modalities, so they inherently rank the clear aligner groups higher. This relationship is logical because those previously treated with clear aligners have had more time with the treatment modality compared to looking at the pictures for a few minutes

during the survey. Further, they have already spent a significant amount of money on clear aligners that furthers their bias.

Dental education and gender do not determine esthetic preferences of orthodontic treatment modalities. The present study showed that there was no statistically significant variation among median VAS scores provided to each treatment modality regardless of a history of dental education. Additionally, gender was not a factor when examining median VAS scores for each treatment modality other than the control with no appliances, which women assigned a slightly higher VAS score. The lack of gender differences in esthetic preferences among American adults has been previously reported<sup>28,29</sup>. Feu et al found that men assigned lower VAS scores to all treatment modalities than females, a difference they deemed to be of minimal clinical significance<sup>27</sup>. Ziuchkovski et al found that history of dental education did not have clinically significant effects on esthetic preferences<sup>26</sup>. Thus, it can be concluded that neither gender nor education play a significant role in how orthodontic treatment modalities are perceived among adults.

Older adults reported treatment modalities involving clear aligners to be more esthetically pleasing than younger adults. The present study revealed that individuals aged 45+ found all treatment modalities involving clear aligners (clear aligners with no attachments, clear aligners with attachments on all maxillary teeth except central incisors, and clear aligners with attachments on all maxillary teeth) to be more esthetic than the group aged 18-25. It has been previously reported that there were no statistically significant differences in esthetic preferences between age groups<sup>28</sup>. Other studies showed that younger participants (17-26) scored clear aligners and clear (sapphire) brackets more positively than the older group<sup>27</sup>. These findings contradict what the present study revealed. Due to conflicting results in the literature, definitive

conclusions cannot be made concerning the effect of age and esthetic perception. More conclusive studies need to be performed that examine age and its effect on how adults perceive orthodontic treatment modalities. A possible explanation for the findings in the present study is that the older individuals (45+) were more likely to have been treated with metal braces and never had clear aligner options presented to them. Thus, they were not aware of clear aligners being a viable treatment modality and scored them higher because they are different than metallic braces. Another potential explanation is that in the last 10-20 years, clear aligners have become much more widely marketed and these older individuals have seen that this modality is much more viable than when they were only offered metal brackets as a treatment option. Finally, the oldest age group only had 80 respondents compared to 366 in the youngest group, so perhaps with a larger population size we would have seen different results.

## V. CONCLUSIONS

1. Aligners with no attachments present on any teeth are most preferred among American adults.
2. American adults consider clear aligners with attachments covering all or most of the maxillary teeth to be no more esthetic than clear brackets.
3. Metal braces are less esthetic than aligners and clear braces, regardless of o-ring color.
4. Adult orthodontic patients previously treated with clear aligners find any treatment modality involving clear aligners to be more esthetic
5. Dental education and gender do not determine esthetic preferences of orthodontic treatment modalities.
6. Older adults reported treatment modalities involving clear aligners to be more esthetically pleasing than younger adults.

## BIBLIOGRAPHY

1. American Association of Orthodontics. (2019). 2018 Economics of Orthodontics Survey conducted by the AAO <https://www1.aaoinfo.org/economics-of-orthodontics-survey-results-highlight-recent-specialty-trends/>
2. Gange P. (2015). The evolution of bonding in orthodontics. *Am J Orthod Dentofacial Orthop.* 147, S56-63.
3. Mizrahi E. (1982). Success and Failure of Banding and Bonding: A Clinical Study. *Angle Orthod.* 52 (2): 113–117
4. Wang W, Li C, Chou T, Wang D, Lin L, Lin C.(2004) Bond strength of various bracket base designs. *Am J Orthod Dentofacial Orthop.* 125(1):65-70.
5. Rix D, Foley T, Mamandras A. (2001). Comparison of bond strength of three adhesives: Composite resin, hybrid GIC, and glass-filled GIC, *American Journal of Orthodontics and Dentofacial Orthopedics*, Volume 119, Issue 1, Pages 36-42,
6. Mandall N, Hickman J, Macfarlane T, Mattick R, Millett D, Worthington H. (2018). Adhesives for fixed orthodontic brackets. *Cochrane Database of Systematic Reviews* Issue 4
7. Matsui S, Umezaki E, Komazawa D, Otsuka Y, Suda N. (2015). Evaluation of mechanical properties of esthetic brackets. *J Dent Biomech.* 6:1758736015574401.
8. Feldner J, Sarkar N, Sheridan J, Lancaster D. (1994) In vitro torque-deformation characteristics of orthodontic polycarbonate brackets. *Am J Orthod Dentofacial Orthop.* 106(3):265-72.
9. Suliman S, Trojan T, Tantbirojn D, Versluis A. (2014) Enamel loss following ceramic bracket debonding: A quantitative analysis in vitro. *Angle Orthod.* 85(4):651-6



10. Viazis A, DeLong R, Bevis R, Douglas W, Speidel T. (1989) Enamel surface abrasion from ceramic orthodontic brackets: a special case report. *Am J Orthod Dentofacial Orthop.* 96(6):514-8.
11. Kesling H. (1946) Coordinating the predetermined pattern and tooth positioner with conventional treatment. *Am J Orthod Oral Surg.* 32:285–293.
12. Buschang P, Shaw S, Ross M, Crosby D, Campbell P. (2014) Comparative time efficiency of aligner therapy and conventional edgewise braces. *Angle Orthod.* 84 (3): 391–396.
13. Miller K, McGorray S, Womack R, Quintero J, Perelmuter M, Gibson J, Dolan T, Wheeler T. (2007) A comparison of treatment impacts between Invisalign aligner and fixed appliance therapy during the first week of treatment. *Am J Orthod Dentofacial Orthop.* 131(3):302.e1-9.
14. White D, Julien K, Jacob H, Campbell P, Buschang P. (2017) Discomfort associated with Invisalign and traditional brackets: A randomized, prospective trial. *Angle Orthod.* 87 (6): 801–808
15. Buschang P, Chastain D, Keylor C, Crosby D, Julien K. (2019) Incidence of white spot lesions among patients treated with clear aligners and traditional braces. *Angle Orthod.* 89 (3): 359–364
16. Rossini G, Parrini S, Castroflorio T, Deregibus A, Debernardi C. (2015) Efficacy of clear aligners in controlling orthodontic tooth movement: A systematic review. *Angle Orthod.* 85 (5): 881–889
17. Buschang P, Ross M, Shaw S, Crosby D, Campbell P. (2015) Predicted and actual end-of-treatment occlusion produced with aligner therapy. *Angle Orthod.* 85 (5): 723–727

18. Papageorgiou S, Koletsi D, Iliadi A, Peltomaki T, Eliades T.(2020). Treatment outcome with orthodontic aligners and fixed appliances: a systematic review with meta-analyses, *European Journal of Orthodontics*, Volume 42, Issue 3, Pages 331–343,
19. Weir, T. (2017). Clear aligners in orthodontic treatment. *Australian Dental Journal*. 62. 58-62.
20. Dasy H, Dasy A, Asatrian G, Rózsa N, Lee H, Kwak J. (2015) Effects of variable attachment shapes and aligner material on aligner retention. *Angle Orthod*. 85(6):934-40
21. Tuncay O. (2006) The Invisalign System. *Quintessence Publishing Co*, 2006:121–132
22. Felin T, Koenderink J, Krueger JI. (2017) Rationality, perception, and the all-seeing eye. *Psychon Bull Rev*.24(4):1040-1059
23. Hoffman, D, Singh, M, Prakash, C. (2015) The Interface Theory of Perception. *Psychon Bull Rev* 22, 1480–1506
24. Drissi-Daoudi L, Doerig A, Parkosadze K, Kunchulia M, Herzog M. (2020) How stable is perception in #TheDress and #TheShoe. *Vision Res*. 169:1-5.
25. Rosvall M, Fields H, Ziuchkovski J, Rosenstiel S, Johnston W. (2009) Attractiveness, acceptability, and value of orthodontic appliances. *Am J Orthod Dentofacial Orthop*. 135(3):276.e1-12; discussion 276-7
26. Ziuchkovski J, Fields H, Johnston W, Lindsey D. (2008) Assessment of perceived orthodontic appliance attractiveness. *Am J Orthod Dentofacial Orthop*. 133(4 Suppl):S68-78
27. Feu D, Catharino F, Duplat C, Capelli Junior J. (2012) Esthetic perception and economic value of orthodontic appliances by lay Brazilian adults. *Dental Press J Orthod*. 17(5):102-14.

28. Thai J, Araujo E, McCray J, Schneider PP, Kim K. (2020) Esthetic perception of clear aligner therapy attachments using eye-tracking technology. *Am J Orthod Dentofacial Orthop.* 158(3):400-409
29. Jeremiah H, Bister D, Newton J. (2011) Social perceptions of adults wearing orthodontic appliances: a cross-sectional study. *Eur J Orthod.* 33(5):476-82.
30. Kuhlman DC, Lima TA, Duplat CB, Capelli Junior J. (2016) Esthetic perception of orthodontic appliances by Brazilian children and adolescents. *Dental Press J Orthod.* 21(5):58-66.
31. Djeu G, Shelton C, Maganzini A. (2005) Outcome assessment of Invisalign and traditional orthodontic treatment compared with the American Board of Orthodontics objective grading system. *Am J Orthod Dentofacial Orthop.* 128(3):292-8; discussion 298.
32. Rossini G, Parrini S, Castroflorio T, Deregibus A, Debernardi CL. (2015) Efficacy of clear aligners in controlling orthodontic tooth movement: a systematic review. *Angle Orthod.* 85(5):881-9.
33. Simon, M., Keilig, L., Schwarze, J. (2014). Treatment outcome and efficacy of an aligner technique – regarding incisor torque, premolar derotation and molar distalization. *BMC Oral Health* 14, 68
34. Meier B, Wiemer KB, Miethke RR. (2003). Invisalign--patient profiling. Analysis of a prospective survey. *J Orofac Orthop.* 64(5):352-8.
35. Kravitz N, Kusnoto B, Agran B, Viana G. (2008). Influence of attachments and interproximal reduction on the accuracy of canine rotation with Invisalign. A prospective clinical study. *Angle Orthod.* 78(4):682-7

36. Karamouzos A, Athanasiou A, Papadopoulos MA. (1997) Clinical characteristics and properties of ceramic brackets: A comprehensive review. *Am J Orthod Dentofacial Orthop.* 112(1):34-40
37. Cacciafesta V, Sfondrini MF, Scribante A, Klersy C, Auricchio F. (2003) Evaluation of friction of conventional and metal-insert ceramic brackets in various bracket-archwire combinations. *Am J Orthod Dentofacial Orthop.* 124(4):403-9

APPENDIX A: FIGURES



**Figure 1.** Images of the model with each orthodontic appliance on her teeth: A) metal braces with grey o-rings; B) clear aligners with attachments on all maxillary teeth; C) metal braces with blue o-rings; D) clear aligners with attachments on all maxillary teeth except U1s; E) ceramic brackets; F) clear aligners with no attachments present

Do you have any history of dental education? (EX:Dental Student/Dentist/Dental Hygiene,etc.)

- Yes, I have had dental education
- No, I have not had dental education

Are you having, or have you had orthodontic treatment in the past?

- Yes, traditional braces
- Yes, clear aligners
- No, I have not had orthodontic treatment

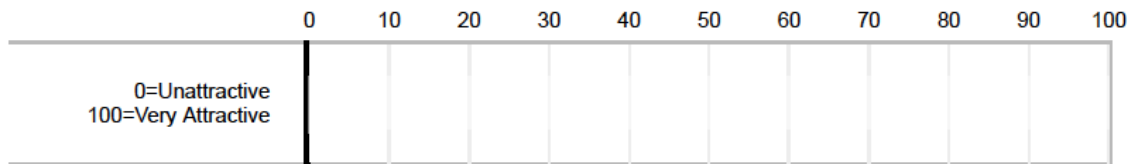
Age Group

- 18-25
- 26-35
- 36-45
- 45+

What is your gender?

- Male
- Female
- Non-binary / third gender
- Prefer not to say

**Figure 2.** Introductory questions from survey



Please rate the following 7 images 0-100 with 0 being very unattractive and 100 being very attractive.

**Figure 3.** Respondents asked to assign a VAS value to each image individually



Please rank the images above by dragging them in descending order from most esthetic (least pleasing)

- A \_\_\_\_\_
- B \_\_\_\_\_
- C \_\_\_\_\_
- D \_\_\_\_\_
- E \_\_\_\_\_
- F \_\_\_\_\_

**Figure 4.** Rank Order – participants were asked to rank the images from most esthetic to least esthetic

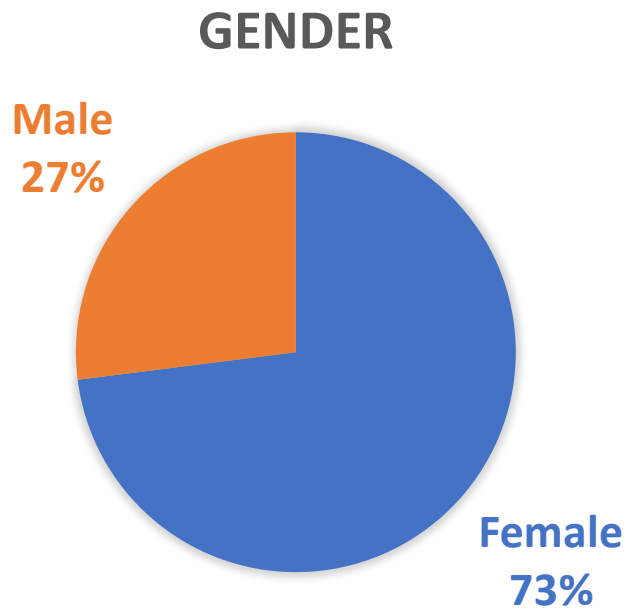
Based on the choice you made above, how much additional would you be willing to spend for the more esthetic (more pleasing) treatment option? (\$0-\$2000)



Would you be willing to be in treatment longer if it meant you got to use the more esthetic (more pleasing) option? If so, how much longer?

- 6 months longer
- 1 year longer
- 2 years longer
- I would not want to be in treatment longer

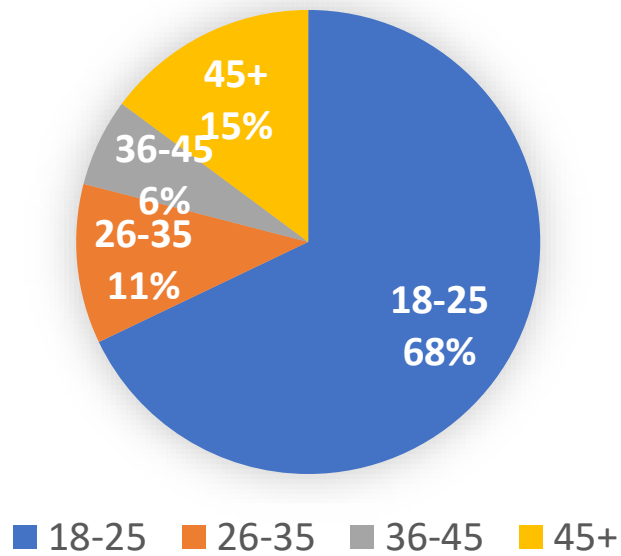
**Figure 5.** Participants were asked how much more money they would be willing to spend for the more esthetic treatment option, and how much longer they would accept being in treatment



**Figure 6.** Descriptive statistics: gender

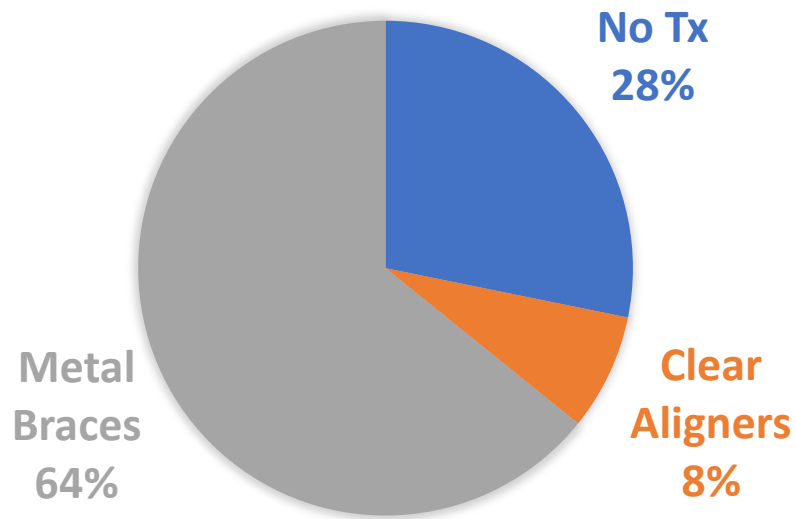


### Age Group



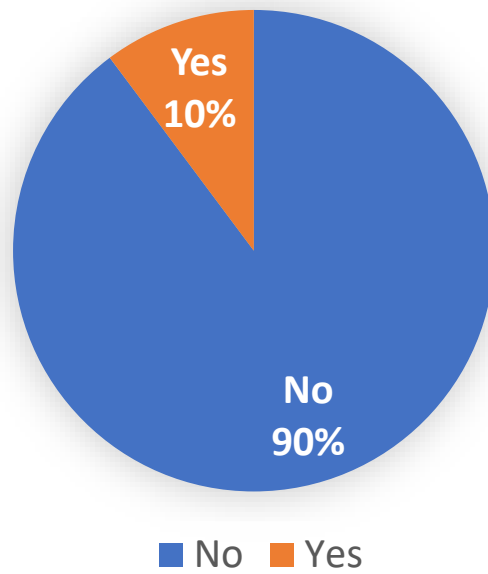
**Figure 7.** Descriptive statistics: age groups

### ORTHO TX IN PAST

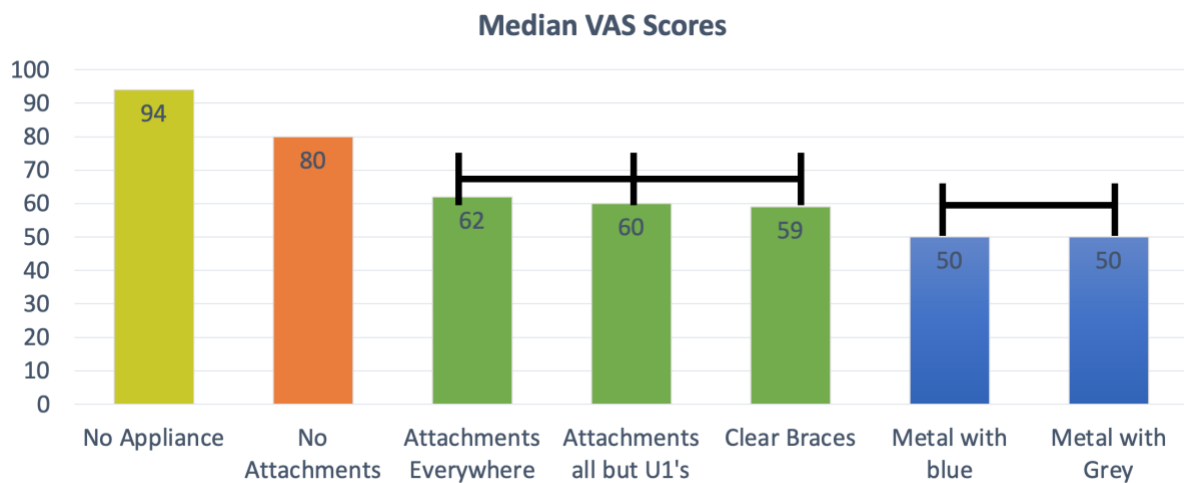


**Figure 8:** Descriptive statistics: history of orthodontic treatment

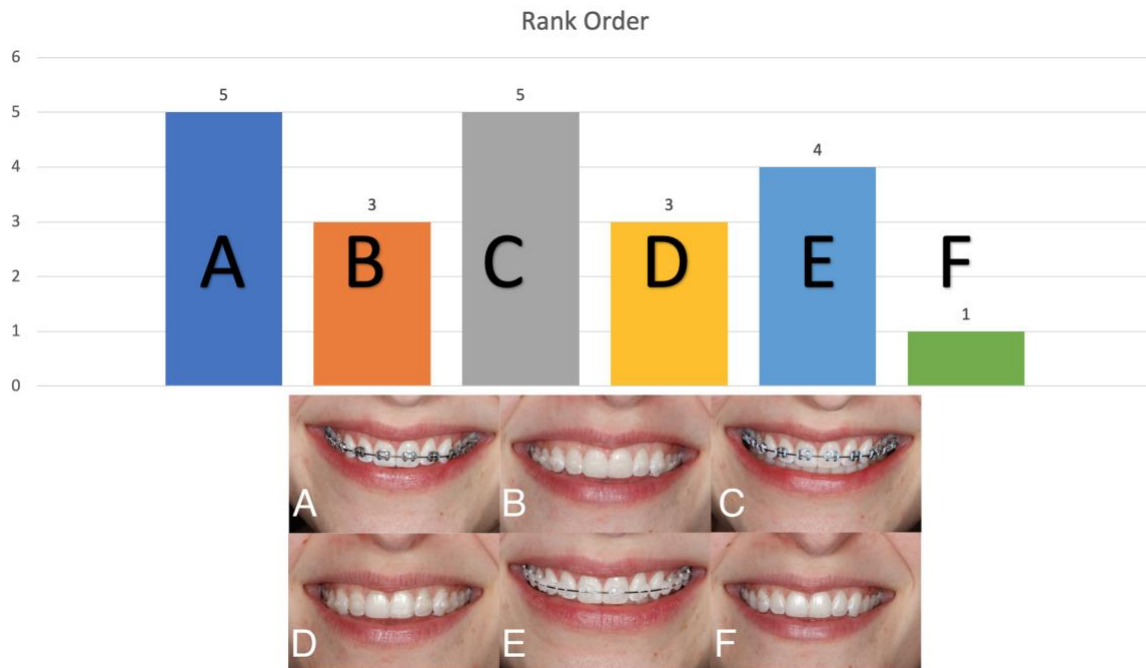
## Dental Education



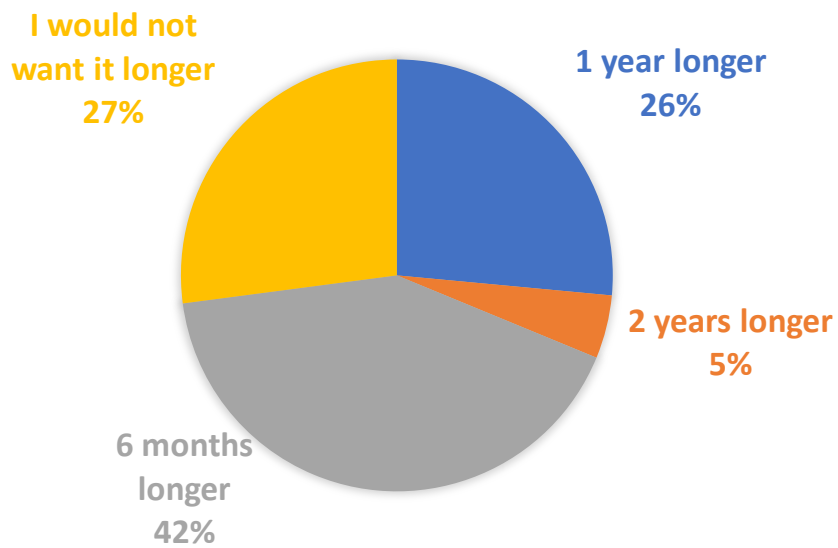
**Figure 9.** Descriptive statistics: history of dental education



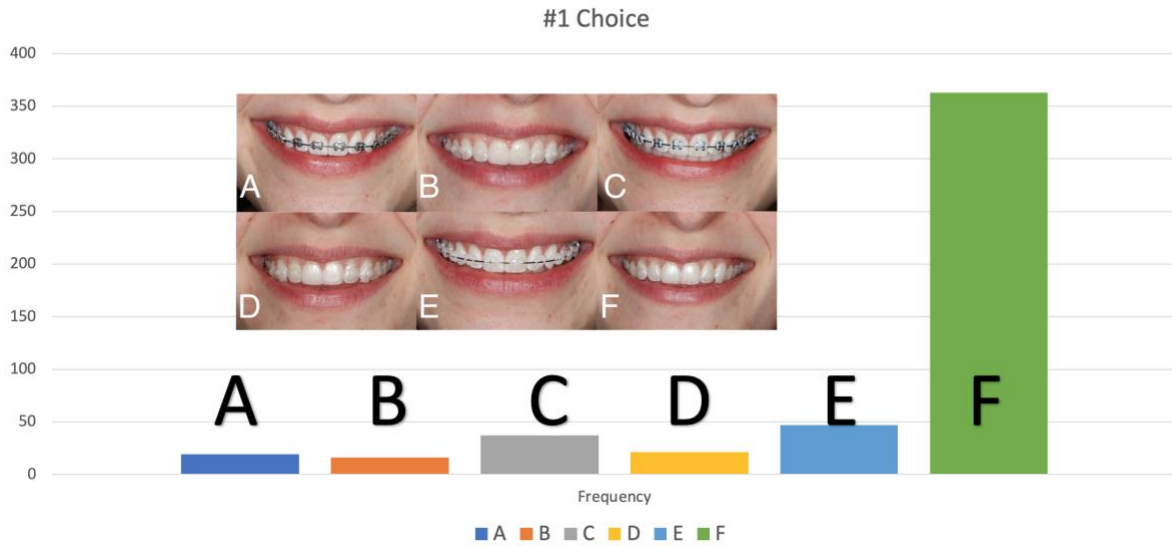
**Figure 10.** Median values assigned to each orthodontic treatment modality



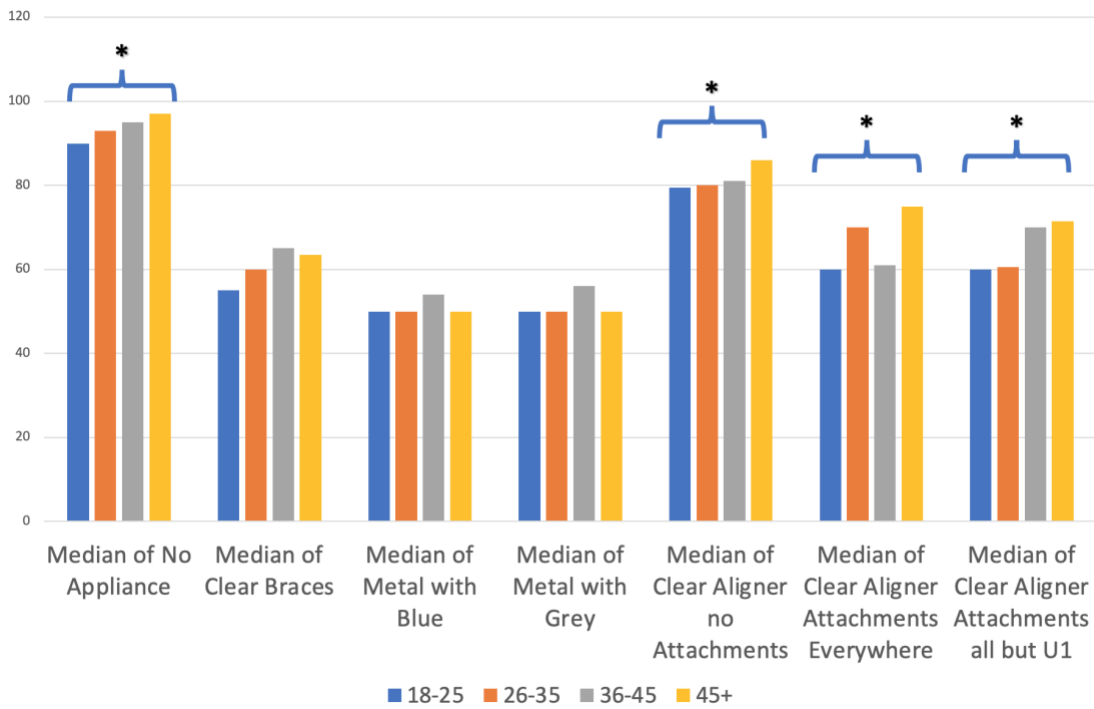
**Figure 11.** Results of rank order



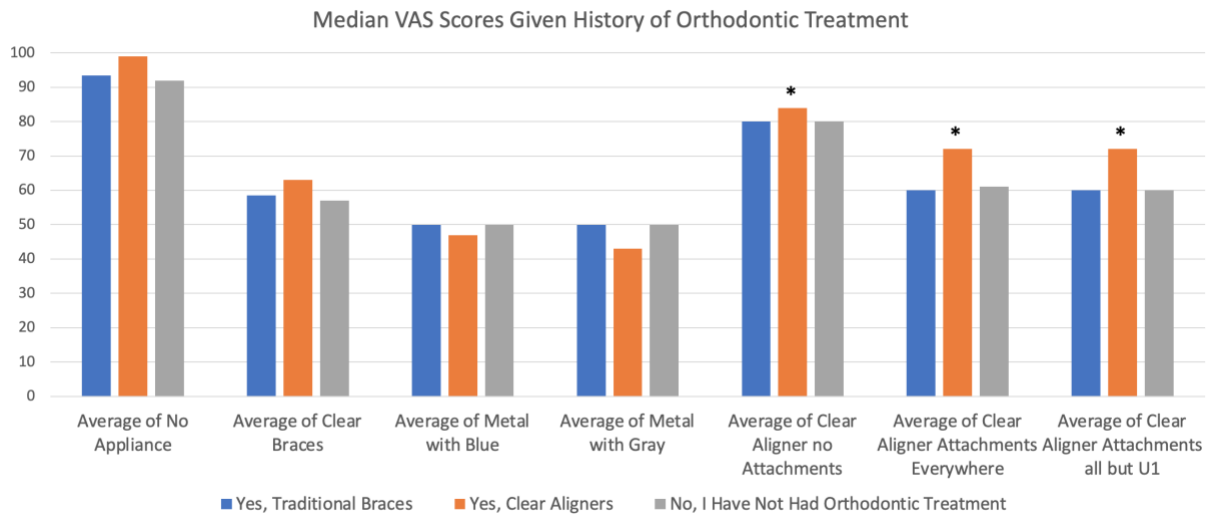
**Figure 12.** How much longer would participants be willing to be in treatment if it meant they were treated with the more esthetic option?



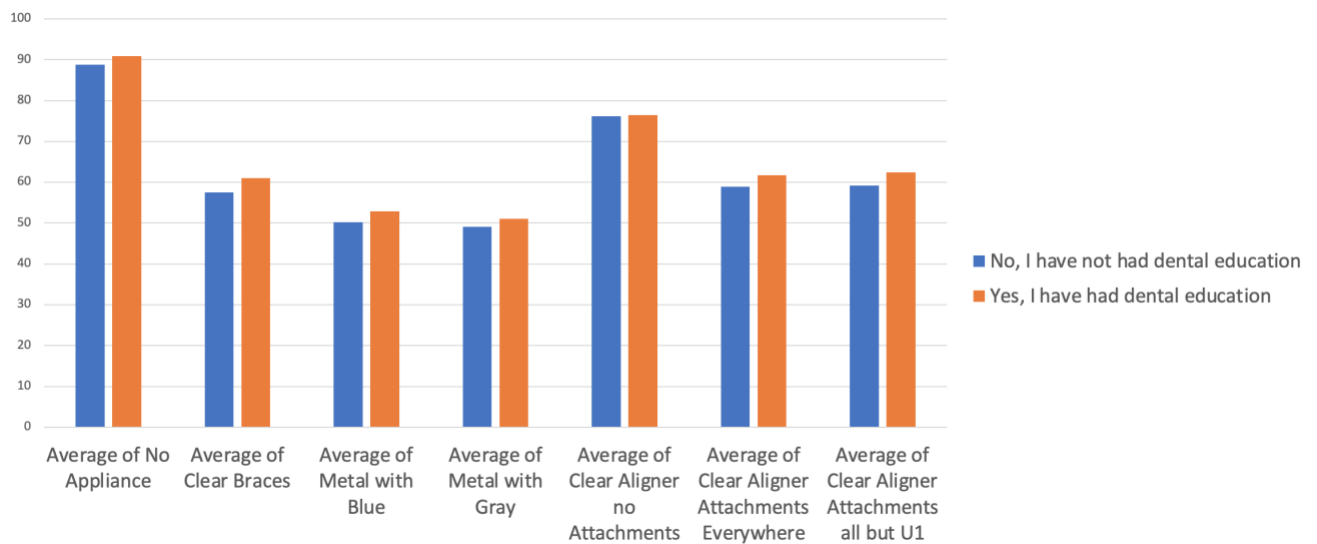
**Figure 13.** When given the choice, which orthodontic appliance would participants most prefer to be treated with?



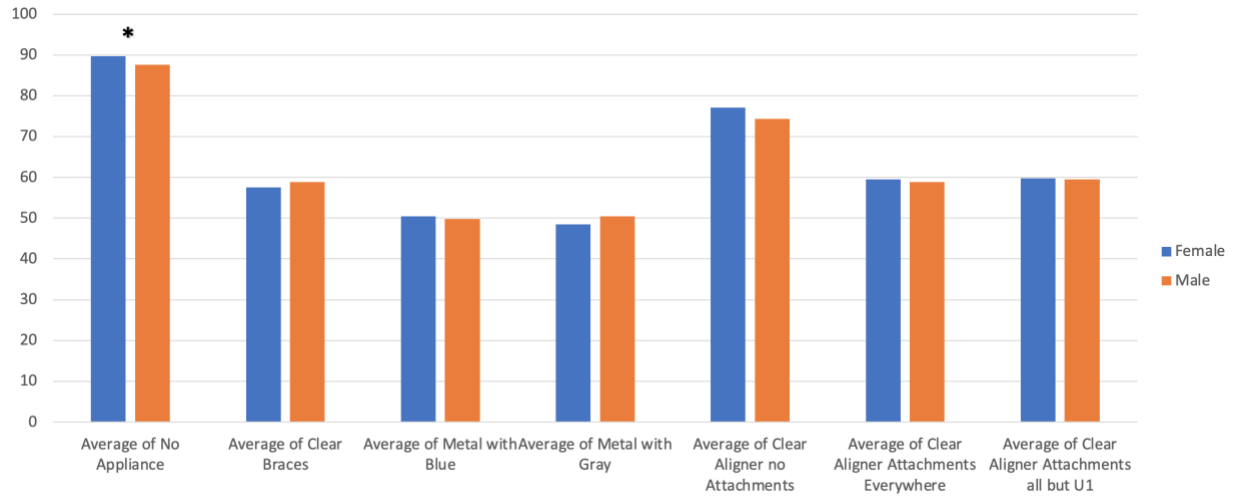
**Figure 14.** Median values assigned to each orthodontic treatment modality when filtered by age group. Statistically significant in-group differences denoted by “\*”.



**Figure 15.** Median scores of orthodontic treatment modalities among those with and without a history of orthodontic treatment. Statistically significant in-group differences denoted by “\*”.



**Figure 16.** Median scores of orthodontic treatment modalities among those with and without a history of dental education



**Figure 17.** Median scores of orthodontic treatment modalities among gender. Statistically significant in-group differences denoted by “\*”.

APPENDIX B: TABLES

Gender (N=530)	Frequency	Percentage (%)
Male	142	27.0
Female	388	73.0

**Table 1.** Descriptive statistics: gender

Age (N=539)	Frequency	Percentage (%)
18-25	366	67.9
26-35	60	11.1
36-45	33	6.1
45+	80	14.8

**Table 2.** Descriptive statistics: age groups

Hx of Orthodontic Treatment (N=539)	Frequency	Percentage (%)
Traditional Metal Braces	346	64.2
Clear Aligners	41	7.6
No Previous Treatment	152	28.2

**Table 3.** Descriptive statistics: history of orthodontic treatment

Dental Education (N=539)	Frequency	Percentage (%)
Yes	55	10.2
No	484	89.8

**Table 4.** Descriptive statistics: history of dental education

Group (N=539)	25 <sup>th</sup> Percentile	Median	75 <sup>th</sup> Percentile
1) No Appliances	81	94 <sup>a</sup>	100
2) Clear Braces	44	59 <sup>b</sup>	73
3) Metal Braces with Blue O-Rings	32	50 <sup>c</sup>	69
4) Metal Braces with Grey O-Rings	30	50 <sup>c</sup>	66
5) Clear Aligners with No Attachments	67	80 <sup>d</sup>	90
6) Clear Aligners with Attachments Everywhere	40	62 <sup>b</sup>	79
7) Clear Aligners with Attachments Everywhere except U1s	43	60 <sup>b</sup>	79

**Table 5.** Median values assigned to each orthodontic treatment modality; distinct superscripts denote statistical significance