HUMAN PREFERENCES FOR FACIAL SYMMETRY

IN DOGS (*CANIS FAMILIARIS*)

by

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ABSTRACT

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Previous studies on facial symmetry have documented a positive correlation between symmetry and perceived attractiveness in both human and non-human subjects. Evolutionary psychologists believe this may be evidence of a biological bias for symmetry based on the assumption that higher degrees of symmetry indicate genetic quality and a successful period of development, which is important for mate selection. The purpose of this study was to determine if this preference for symmetry would emerge if subjects were asked to assess facial attractiveness of hetero-specifics, specifically dogs, *Canis familiaris*. Three levels of symmetry of a frontal photograph of a dog's face were created: perfectly symmetrical (a blending of the normal photo with its mirror image), normal and asymmetrical (a 10% increase in asymmetry). The photographs were paired in three possible combinations and shown simultaneously to dog breeders as well as non-dog breeders. Chi-square and binomial tests were used to detect differences in proportions between the three comparisons varying in symmetry. Findings suggest both breeders and non-dog breeders found symmetry attractive. Out of the three types of comparisons, the non-dog breeder's had the highest preference for the more symmetrical face for the asymmetrical/perfectly symmetrical comparison. However, the dog breeders had similar preferences for the more symmetrical face for both the asymmetrical/perfectly symmetrical and perfectly symmetrical/normal comparisons. Limitations and future studies are also discussed.

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CHAPTER 1

INTRODUCTION

1.1 Background

Previous studies on facial symmetry have documented a positive association between symmetry and perceived attractiveness in both human (Fink, Neave, Manning & Grammer, 2006; Rhodes, Proffitt, Grady & Sumich, 1998; Grammer & Thornhill, 1994, Thornhill & Gangestad, 1994) and non-human subjects (Waitt & Little, 2006). Additional studies have also found that these preferences persist across cultures (Rhodes, Yoshikawa, Clark, Lee, McKay & Akamatsu, 2001). Evolutionary psychologists believe this may be evidence of a biological bias for symmetry based on the assumption that higher degrees of symmetry indicate genetic quality and a successful period of development, which is important in mate selection (Møller, 1997). Shykoff and Møller (1999) were the first to directly test whether symmetry could predict an organism's developmental buffering ability. The results of the study confirmed that those who were less affected by detrimental environments during development were able to maintain developmental homoeostasis (i.e. symmetrical bilateral traits) and were more reproductively successful than were those unable to cope with such disturbances in development.

1.1.1 Types of Bilateral Asymmetry

During development there are three distinct types of bilateral asymmetry that occur in organisms, including directional asymmetry (deviations with a genetic basis that cause one side to be consistently larger than the other), anti-symmetry (normal deviations in the population that occur at random and have no genetic basis), and fluctuating asymmetry (FA) (deviations with no directionality). It is FA that many researchers believe to be a key measure of an organism’s inability to develop along predetermined developmental paths (Van Valen, 1962). The results from a study by Livshits and Kobyliansky (1991) support this link between FA and developmental instability. They found levels of FA in bilateral traits were significantly higher for those who experienced distress or disease during development. Predation, lack of nutrition, temperature and mutation may also deter an individual's ability to express a symmetrical bilateral trait (Møller & Swaddle, 1997). Therefore, it could be suggested that quality might be signaled by an individual's ability to buffer against such disruptions in development.

1.1.2 Attractiveness of Symmetry

If symmetry does in fact signal genetic quality, then it would be advantageous to adaptation that would help one to choose a more symmetrical mate, because quality mates are more likely to have surviving offspring which in turn allows one to be more reproductively successful. Many researchers believe that perceiving a higher level of symmetry as more attractive is such an adaptation (Jones, Little, Penton-Voak, Tiddeman, Burt & Perrett, 2001; Rhodes et al., 1998, Grammer & Thornhill, 1994).

Recent studies have shown that lower levels of FA are perceived to be more attractive (Fink et al., 2006; Simmons, Rhodes, Peters & Koehler, 2004; Hume & Montgomerie, 2001; Rhodes et al., 1998; Grammer & Thornhill, 1994) even after controlling for natural covariates of symmetry such as mean trait size, age or overall facial shape (Mealy, Bridgstock & Townsend, 1999). Furthermore, through various manipulation techniques, studies have found that attractiveness increases as facial symmetry increases (Perrett, Burt, Penton-Voak, Lee, Rowland & Edwards, 1999; Rhodes et al., 1998). However, some earlier studies have found that higher levels of symmetry were perceived as less attractive (Knower, 1996; Swaddle & Cuthill, 1995).

1.1.3 Symmetry Manipulation Experiments

The conflicting results may be explained by the methods used to increase symmetry in earlier studies. Rhodes (2006) suggested that more symmetrical photos that are constructed from mirror images are more likely to be viewed as abnormal. This can be attributed to either abnormalities in the original photo (i.e. crooked nose) or subjects not looking directly towards the camera. These slight deviations can create hemifaces that are either abnormally wide or narrower causing them to be perceived as less attractive. Instead of using mirror images, later studies increased facial symmetry by using blending and morphing techniques that created more natural faces.

1.2 Exploratory Study

The current study was based on previous research by Autrey in 2006. The purpose of her exploratory study was to determine if preferences for symmetry would emerge if subjects were asked to assess facial attractiveness of hetero-specifics. The study used photos of various mixed and pure bred dogs obtained from a local animal shelter. It was of interest to determine if symmetrical dogs would be judged as more attractive by human raters, and subsequently more likely to be adopted than asymmetrical dogs. Participants viewed 80 photographs and rated each dog's level of attractiveness on a 7 point Likert scale. Unfortunately, no significant correlations were found between perceived attractiveness and actual symmetry or between symmetry and adoptability. However, the previous study relied on a sequential presentation of the photographs that may have confounded the results. By viewing and rating the photographs individually, perceived attractiveness for symmetry may have had to compete against other variables including color, breed and age of the animal. It was believed that an alternative assessment procedure might be able to generate significant results. Instead of evaluating the dogs individually, participants would directly assess pairs of photos with varying degrees of symmetry simultaneously (similar to the Rhodes et al., 1998 study).

1.3 Hypotheses

Experiment one was designed to explore whether the use of hetero-specifics would produce any differential effects upon individual's preferences for symmetry. Specifically, though not necessarily at a conscious level, would individuals be able to detect subtle differences between pairs of dogs with varying degrees of symmetry, and if so, would they choose more symmetrical faces as the most attractive? Two different types of assessment were used to test the assumptions, including forced-choice assessments of three comparison conditions (perfectly symmetrical/unaltered or normal, normal/asymmetrical and asymmetrical/perfectly symmetrical) and a ranking assessment of attractiveness of all the dogs used in the study. A hierarchical cluster analysis, based on the rank order of dogs from favorite to least favorite, was used to subdivide the dogs into smaller groups based on the similarities within the groups. The goal was to identify the dog characteristics that are similar within each cluster as well as the dissimilarities between the clusters.

Two predictions were made for the first experiment. Because it has been suggested in previous studies that symmetry is positively correlated with perceived attractiveness in human studies, it was expected that individuals would choose more symmetrical photographs as the most attractive when given a choice between pairs of dogs with varying degrees of symmetry. It has also been suggested that preferences strengthen as the asymmetrical differences between pairs of faces increases (Rhodes et al., 1998), so it was expected that the strongest preference would be for the asymmetrical/perfectly symmetrical comparison. The next highest preference would be for normal/asymmetrical comparison followed by the perfectly symmetrical/normal comparison. No predictions were made for the results of the ranked data, as this was an exploratory analysis and there was no theoretical framework from which to estimate how many clusters would be formed or what similar features would determine the clusters. Two additional experiments were used to replicate, as well as to expand upon the findings of the first experiment.

The purpose of experiment 2 was to increase the overall sample size of the non-dog breeders from the first experiment and to explore whether preferences for symmetry in a hetero-specifics were repeatable.

The purpose of experiment 3 was to explore whether dog breeders would be better able to detect subtle differences in symmetry compared to non-dog breeders. Previous studies have suggested the relationship between facial symmetry and perceived attractiveness may be evidence of a biological bias for symmetry. Specifically, that symmetry may be perceived as attractive because it indicates genetic quality which is important in mate selection. Because humans do not choose dogs to mate with, but chose them to be companions or working partners, the previous experiments were unable to provide support for this assumption since a person's reproductive success is not affected by the level of symmetry in their pets. We proposed that by including dog breeders we might be able to find support for the biological bias assumption because the breeder's chief concern is to choose quality dogs suitable for the purpose of breeding. With the data from the second experiment as a baseline for symmetry preferences, the third experiment compared the non-dog breeder's responses with responses of dog breeders.

Similar to the predictions in the first and second experiment, it was expected that dog breeders would choose more symmetrical photographs as the most attractive when given a choice between pairs of dogs with varying degrees of symmetry. It was predicted that the strongest preference would be for the asymmetrical/perfectly symmetrical comparison, then the normal/asymmetrical comparison followed by the perfectly symmetrical/normal comparison. Because specific characteristics indicating genetic quality are important to dog breeders, it was also expected that they would be better able to detect smaller differences in symmetry compared to non-dog breeders. Specifically, it was expected that dog breeders would prefer higher levels of symmetry overall and prefer higher levels of symmetry significantly more in each of the three types of comparisons compared to non-dog breeders. Again, due to the fact that there was no theoretical framework from which to estimate how many clusters would be formed from the ranked data, no predictions were made for these results.

CHAPTER 2

EXPERIMENT ONE

2.1 Methods

2.1.1 Participants

Twenty-eight undergraduate students (19 females and 9 males with a mean age of 24.5, see Table C.1) from the University of Texas at Arlington were used in this experiment. The students were enrolled in an evolutionary psychology course during the spring semester of 2008. As part of an introduction to the topic of facial symmetry, the students were asked to participate in the following experiment. No compensation was given to those that agreed to participate. The experiment took a total of 20 minutes to complete.

2.1.2 Stimuli

Twenty of the highest quality photos were selected from the photographs used in the Autrey (2006) study. The photographs were of dogs that varied in color, age, size and breed type. For each frontal facial image, the background was removed and replaced with a white background in order to maintain consistency in all photographs.

2.1.2.1 Facial symmetry analysis

To create the three levels symmetry, the symmetry of each dog was measured using several predetermined facial landmarks. Because we were measuring the FA of another species, we modified the set of landmarks used by the Grammer & Thornhill (1994) study. Facial points unobstructed by facial hair and points that showed relatively small individual differences across the sample were the criteria for choosing the facial points in this study. A free Java image processing program called ImageJ 1.41 was used to measure the set points in pixels. After reviewing facial structures of several photos of dogs, only eight of the original facial points used by Grammer & Thornhill (1994) were retained. The points included were the outer eye corners (P1 and P2), the corners of the inner eye (P3 and P4), the outermost part of the cheekbones (P5 and P6) and the outermost part of the nose (P7 and P8). To calculate asymmetry, a midline was defined by the average midpoints of four bisected lines that were created by connecting the following points: P1-P2, P3-P4, P5-P6 and P7-P8 (see Figure B.1). The distance between the midline and the right and left sides for each bisected line were summed. This sum was then divided by the difference between the two sides of the bisecting line, and then subtracted by one. The total asymmetry for each dog was then calculated by summing the individual asymmetry of each bisected line and then dividing by the total number of bisected lines. On a perfectly symmetrical face, the differences between the right and left side would be normally distributed and have a mean of zero.

2.1.2.2 Generation of composites

Once the asymmetry of the unaltered dog was calculated, we were able to create the three levels of symmetry (perfectly symmetrical, unaltered (normal image) and asymmetrical) from the frontal facial photograph of each dog. The perfectly symmetrical version was created by taking the mirror image of each photo and blending it with the unaltered image in Adobe Photoshop (similar to Rhodes et al., 1998). It was important to maintain the symmetry of the predetermined landmarks, but at the same time maintain the original color and textural information for each dog. Once features were in position, the original coloring and/or markings were retained for each set of comparisons. Finally, the asymmetrical version was created by increasing the asymmetry of the original photo by 10 percent. The photographs were then paired in the three possible combinations, asymmetrical/perfectly symmetrical (A/P), normal/asymmetrical (N/A), and perfectly symmetrical/normal (P/N).

2.1.3 Design and Procedure

At the end of class, students were informed by the experimenter that they had the option of taking part in an experiment designed to assess facial attractiveness of dogs. The students who chose to participate were handed a questionnaire (see Appendix A.1). Participants then viewed a PowerPoint presentation where they were presented with 60 pairs of dogs. Each pair was presented simultaneously and the left right presentation, for all three comparisons, was counterbalanced. For each pair the participant had to identify which dog, at first impression, was more appealing. They were told that there were slight differences within each pair. Participants were then given 7 seconds to select the preferred dog with a 2 second delay between pairs. To minimize fatigue, participants were shown three sets of 20 photographs with two breaks in between. Before the experiment began, three test slides were shown in order to familiarize the participants with the format. The cross sectional design of the study allowed for the measurement of the relationships between perceived attractiveness and symmetry, as well as perceived attractiveness across the three types of symmetry conditions.

Once the participants viewed the 60 pairs of dogs, a slide with all 20 unaltered dogs appeared on the screen and the participants were then asked to rank the dogs from favorite to least favorite. Demographic information including age, gender, relationship status and pet ownership were also obtained. Upon completion, the questionnaires were collected and the participants were debriefed.

2.2 Data analysis

For the first hypothesis, when given a choice between two versions of the same face participants would prefer the more symmetrical image; a chi-square goodness of fit was used to see whether preferences were significantly associated with higher levels symmetry. It was expected that participants would prefer more symmetrical faces within each pair of dogs.

For the second hypothesis, participants would have the strongest preference for the A/P comparison, the second strongest preference for the N/A comparison and the least preference for the P/N comparison. A chi-square test was used explore how the levels of symmetry were associated with perceived attractiveness. The chi-square test compared the distribution of observed scores to scores that we might have expected to occur by chance. The three types of symmetry comparisons were placed in the rows and symmetry preferences were placed in the columns, in order to compare the patterns of distribution for the responses to varying degrees of facial symmetry along the dependent variable (pairs of pictures: preference for less symmetry or more symmetry) between the values of the independent variable (P/N, N/A and A/P). The standardized residuals were used to evaluate the association between the two variables and indicate strength and direction.

Because of the exploratory nature of the study, a hierarchical cluster analysis was used to identify groups of dogs based on preference ratings. It was expected to yield insight into the role of symmetry, overall attractiveness, and breed characteristics that may influence human preferences for certain dogs.

2.3 Results

The first hypothesis predicted that level of symmetry would be associated with responses to which dog the participants perceived as the most attractive. Specifically, it was expected that participants would be sensitive to varying degrees of facial symmetry in a hetero-specific (dogs), and in turn, would view more symmetrical faces as the most attractive. The chi-square goodness of fit confirmed that the preferences for more or less symmetry were not equally distributed among the sample, $\chi^2(1, N = 1680) = 36.02$, $p < .001$. The analysis showed that 57% of the participants perceived more symmetrical faces as the most attractive. The results confirmed hypothesis 1.

The second hypothesis predicted that level of symmetry would be associated with reported preferences over the three types of symmetry comparisons. Specifically, it was expected that the strongest preference for higher levels of symmetry would be for the asymmetrical/perfectly symmetrical comparison. The next highest preference would be for normal/asymmetrical comparison followed by the perfectly symmetrical/normal comparison. A comparison of preferences over levels of symmetry, yielded a significant association with the three types of symmetry comparisons, $\chi^2(2, N = 1680) = 12.540$, $p < .01$. The results showed that majority of participants (63%) reported the perfectly symmetrical face as the most attractive in the A/P comparison (Figure B.2). Within the P/N and N/A comparisons, the former chose the more symmetrical photo 53% of the time and the later chose the more symmetrical 56%. Standardized residuals were then used to further describe the relationships and indicate strength and direction. The results showed a trend for choosing photos with higher levels symmetry across the three symmetry comparisons, but the preferences were not above expected levels. It was found that the only major contributor to the significant chi-square test statistic was that the participants preferred the less symmetrical face in the A/P condition significantly less than expected. While the results suggest a weak but significant relationship between type of symmetry condition and symmetry preference, the standardized residuals indicate that the data did not support hypothesis 2.

A binomial test was then used to see if the preference for the more symmetrical photo in each condition was at least above chance levels. It was found that more symmetrical faces were significantly preferred above chance levels in both the A/P (binomial test: $p < .001$, Table C.2) and N/A (binomial test: $p < .01$) conditions, but not for the P/N (binomial test: NS).

An agglomerative hierarchical clustering procedure using average linkages and squared Euclidian distances was used to identify groups of dogs based on preference ratings. Because of the exploratory nature of the cluster analysis no predictions were made regarding the results. The dendrogram presented in Figure B.3 illustrates the hierarchical clustering process applied to the preference ratings from the 28 participants. Based on the dendrogram, five clusters were identified. After assessing the “optimal ratio between loss of variance and the number of clusters” as well as the total number of dogs in each cluster, it was decided that only three of the clusters could be used to identify what might be influencing the preferences for certain dogs (Claes & Ruiz-Quintanilla, 1993). Table C.3 provides a brief description of the dogs contained in each cluster. Two one way ANOVA’s were used on the remaining clusters in order to determine the defining characteristics.

The first ANOVA was used to examine the group differences between clusters (independent variable) on measures of preference ratings (dependent variable). The means and standard deviations for each cluster can be seen in Table C.4. The assumption of equal variances on the preference ratings across the 3 clusters was satisfied. For the preference ratings, there was a significant difference between the clusters ($F(2, 14) = 34.24$, $p < .001$, $\eta^2 =$

.830; Table C.5). The Tukey post-hoc comparisons revealed that all three means were significantly different from each other. Participants gave dogs in cluster 3 (M = 8.11) significantly higher preference ratings than cluster 2 (M = 10.05) and cluster 1 (M = 12.60). Dogs in cluster 2 had significantly higher preference ratings than cluster 1. Without further analysis, it could only be assumed that certain variables were having a significant influence on the way the participants were ranking the dogs.

As a result, a second ANOVA was used to examine the group differences between clusters (independent variable) on measures of calculated asymmetry (dependent variable). The means and standard deviations for each cluster can also be seen in Table C.4. The assumption of equal variances was satisfied. For the asymmetry measures, there was a significant difference between the clusters ($F(2, 14) = 5.610$, $p < .05$, $\eta^2 = .445$; Table C.6). Post hoc comparisons using Tukey procedures were used to determine how the three group means differed. While dogs in cluster 3 (M = .98) had significantly higher levels of symmetry than cluster 2 (M = .96), there were no significant differences in symmetry between dogs in cluster 1 (M = .97) and dogs in cluster 2 or cluster 3.

After comparing the two ANOVA's it was found that the highest ranking dogs and the lowest ranking dogs had similar overall levels of symmetry. Both clusters were reviewed in order to examine the makeup of dogs in each cluster. According to a list of aggressive breeds found on dogobedienceadvice.com, the lowest ranking cluster was made up of dogs that were considered both "potentially" aggressive as well as dogs that were typically not aggressive but had "bad images" (http://dogobedienceadvice.com/which_dog_breeds_are_most_aggressive.php). None of the dogs in the highest ranking cluster were on the "potentially" aggressive list. This suggests that perceived attractiveness might have been competing against preconceived notions about certain breeds. So, the participants might have rated dogs in the lowest ranked cluster (cluster 2) as less attractive because they considered them more aggressive. Altogether, these results show additional support for the first hypothesis that level of symmetry is associated with responses to which dog the participants perceived as the most attractive.

2.4 Discussion

The purpose of this study was to replicate the findings of Perrett, et al (1999) and Rhodes et al. (1998) regarding the positive relationship between perceived attractiveness and symmetry. These studies found, through various manipulation techniques, that subject's perceived higher levels of symmetry as more attractive. The intention of this study was to explore whether the use of hetero-specifics would produce similar differential effects upon individual's preferences for symmetry. Specifically, would individuals be able to detect subtle differences between pairs of dogs with varying degrees of symmetry, and if so, would they choose more symmetrical faces as the most attractive? Three questions were created to test whether a positive relationship between attractiveness and symmetry could be found when assessing hetero-specifics (dogs). First, would participants choose more symmetrical photographs as the most attractive overall when given a choice between pairs of dogs with varying degrees of symmetry? If support was found for the first hypothesis, then would these preferences for higher levels of symmetry strengthen as a function of increasing asymmetrical differences between the pairs? Finally, if one is asked to rank order a variety of dogs from favorite to least favorite, how does symmetry, overall attractiveness, and type of breed influence human preferences for certain dogs? After running several statistical analyses, only the first hypothesis was fully supported.

To begin with, there were significant differences in responses to which dogs the participants perceived as most attractive. The results showed that 57% of the participants did perceive the more symmetrical faces as the most attractive. The findings support the first hypothesis as well as the findings of the Perrett, et al (1999) and Rhodes et al. (1998) studies.

The second hypothesis was not supported by the data. The null hypothesis was that increases in asymmetrical differences between pairs of dogs would not affect preferences for higher levels symmetry. Since 57% of the total sample perceived higher levels of symmetry as more attractive, then we would expect the participants would choose the more symmetrical photo as the most attractive around 57% of the time across all three types of comparisons if the null were true. The results showed that participants did prefer the more symmetrical photos 63% of the time in the A/P comparison, 56% of the time in the N/A comparison, and 53% of the time in the P/N comparison. The findings suggest that with increasing asymmetrical differences there was trend for preferring photos with higher levels symmetry, but the preferences were not above expected levels. In fact, the participants choosing the less symmetrical face as the most attractive significantly less than expected in the A/P comparison was the only major contributor to the significant chi-square test statistic. This suggests that while there was a significant relationship between type of comparison and symmetry preference, the two were only weakly related. One reason for this result might have been that participants were having a difficult time detecting subtle differences between the different pairs of dogs with smaller difference in symmetry.

Although there was only a weak relationship between preferences for higher symmetry and the three types of symmetry comparisons, the binomial test suggested that symmetry was significantly preferred above chance levels in both the A/P and N/A condition, but not for the P/N condition. This again suggests that photos with higher levels of symmetry were preferred but that the participants were not as sensitive to the symmetrical cues between pairs of dogs with subtle differences in symmetry.

Finally, the dogs' rank ordered scores were assessed to see what variables might have influenced human preferences for certain dogs. The analysis was expected to yield insight into how symmetry, attractiveness, and breed characteristics might influence the observed preferences. The result of the cluster analysis indicated a three cluster solution. Further analysis suggested that the dogs in each cluster varied significantly from each other by their rank ordered scores. Specifically, cluster 1 had the lowest ranking dogs, cluster 3 had the highest ranking, and the dogs in cluster 2 were ranked somewhere in between. The clusters were also found to have significant mean differences in their overall symmetry. While the overall mean symmetry was significantly different between the highest ranking cluster (cluster 3) and the mid ranking cluster (cluster 2), there were no significant mean differences in symmetry between the lowest ranking cluster (cluster 1) and cluster 2 or 3. The most interesting part here was that the highest ranking dogs and the lowest ranking dogs had similar overall levels of symmetry. After reviewing the both clusters it was found that the lowest ranking cluster was made up of dogs that were considered both "potentially" aggressive as well as dogs that were typically not aggressive but had "bad images", while the highest ranking cluster contained no dogs on the "potentially" aggressive list. This suggests that the type of breed might have had an influence on how the participants ranked the dogs from favorite to least favorite. If the participants did perceive the dogs in cluster 1 as more aggressive, this might explain their subsequent decision to rank them significantly lower than the dogs with similar levels of symmetry. Altogether, these results show additional support for the first hypothesis that level of symmetry is associated with responses to which dog the participants perceived as the most attractive. Though it is obvious that symmetry is not the only factor one uses when determining preferences.

Because the analysis of the standardized residuals from the chi-square test of independence showed that preferences were not above expected levels another experiment was conducted. There was some concern about a lack of statistical power due to the small sample size; therefore the sample size was increased in experiment 2. The expectation was that with increased power we would be better able to detect subtle differences in preferences across the three types of comparisons.

CHAPTER 3

EXPERIMENT TWO

3.1 Methods

3.1.1 Participants

One hundred and sixty-one participants were recruited from the University of Texas at Arlington. Of the 161 participants, three were excluded for age, one was excluded for not following study procedures and eight participants were excluded for stating the hypothesis during a manipulation check. One hundred and forty-nine participants completed the experiment and received course credit for participating (112 females and 37 males with a mean age of 20.42, see Table C.7)

3.1.2 Stimuli

The same 20 photographs from experiment 1 were used in experiment 2.

3.1.3 Design and Procedure

Instead of having the participants record their responses on a questionnaire, the participants were asked to view the 60 pairs of dogs in a presentation created in E-prime. E-prime is an interactive program that allows the participant's responses to be recorded directly to a data file, which helped to ease the data collection process. Each dog pair was still presented simultaneously, in the left right presentation, for all three comparisons, and counterbalanced. For each pair the participants identified which dog, at first impression, was more appealing. They were told that there would be slight differences within each pair. Participants were given 7 seconds to select the preferred dog by placing the mouse pointer over the dog they found most attractive and clicking. There were also given a 2 second delay between pairs. To minimize fatigue, participants were shown three sets of 20 photographs with two breaks in between. During the breaks the participants were asked demographic information including age, gender, relationship status, pet ownership and whether or not they are a dog breeder or handler. Before the experiment began, three test slides were shown in order to familiarize the participants with the format. The cross sectional design of the study allowed for the measurement of the relationships between perceived attractiveness and symmetry, as well as perceived attractiveness across the three types of symmetry comparisons.

Once the participants viewed the 60 pairs of dogs, a slide with all 20 dogs appeared on the screen and the participants were asked to rank the dogs from favorite to least favorite by clicking on each of the 20 dog photos at the bottom of the screen and dragging them into a grid at the top of the screen. The grid contained 20 numbered squares, thus allowing them to rank the dogs from most attractive (grid box one) to least attractive (grid box 20). All participants were debriefed via email in order minimize bias that may have occurred by debriefing participants in front of individuals waiting to take part in the experiment. The email included a description of the research study, along with the results and a brief explanation of the findings.

3.2 Data analysis

Because experiment 2 was used to replicate and to extend the findings of experiment 1, all hypotheses remained the same.

3.3 Results

As expected, the preferences for more or less symmetry were again not equally distributed among the sample, $\chi^2(1, N = 8940) = 134.36$, $p < .001$. It was found that 56% of the participants perceived more symmetrical faces as the most attractive.

We also predicted that participant's preferences for symmetry would strengthen as level of symmetry increased across the three types of comparisons. A chi-square test of independence examined this relationship and the results indicated a significant association between preferences and the three types of symmetry comparisons, $\chi^2(2, N = 8940) = 26.66$, $p < .001$. More participants than expected (60%) preferred the more symmetrical face in the asymmetrical/perfectly symmetrical (A/P) comparison, see figure B.4. In the normal/asymmetrical (N/A) comparison 55% of the participants selected more symmetrical faces as the most attractive. Finally, the participants preferred the more symmetrical face less than expected (53%) in the perfectly symmetrical/normal (P/N) comparison. The standardized residuals indicated a trend for choosing photos with higher levels symmetry, but the preferences were only above expected levels in two conditions (A/P and N/A condition). The results suggest a significant relationship between type of symmetry comparison and symmetry preference, which is consistent with hypothesis two.

A binomial test was then used to assess whether the participants preference for higher degrees of symmetry in each condition was above chance levels. It was found that more symmetrical faces were significantly preferred above chance levels in all three comparisons: A/P (binomial test: $p < .001$, Table C.8), N/A (binomial test: $p < .001$) conditions, and P/N (binomial test: $p < .001$).

Further analysis showed that while there were no significant differences in reaction times between the three types of comparisons, there were significant differences between the participant's reaction times and strength of preference. Participants with higher symmetry preference scores were more likely to have slower reaction times (F (5,143) = 3.554, $p < .01$, $\eta^2 = .912$).

An agglomerative hierarchical cluster analysis was then used to categorize the ranked data from the participants. The resulting dendrogram from an agglomerative hierarchical clustering procedure suggested that participants ranked the dogs in two distinct clusters (Figure B.5). Table C.9 provides a brief description of the dogs contained in each cluster. To identify what factors might have influenced their preferences for certain dogs several variables were analyzed. Again, because of the exploratory nature of the cluster analysis no predictions were made regarding the results.

A t-test was used to examine the group differences between clusters on measures of preference ratings. The means and standard deviations for each cluster can be seen in Table C.10. The assumption of equal variances on the preference ratings across the two clusters was satisfied. There was a significant difference between the clusters overall preference ratings (t

(18) = 3.386, p < .01). Participants gave dogs in cluster 1 (M = 9.18) significantly higher preference ratings than cluster 2 (M = 12.96).

Another t-test was used to examine the group differences between clusters on measures of calculated asymmetry. The means and standard deviations for each cluster can also be seen in Table C.10. The assumption of equal variances was satisfied. For the asymmetry measures, there was no significant difference between the clusters (t (18) = .308, p = .76). Because the results from the cluster analysis differed from experiment 1, further tests were used to identify additional ways in which the clusters may have been formed.

After examining the make up of each cluster, it was found that 7 of the 13 dogs listed in the highest ranking cluster were considered the most popular in 2008 (a full list can be obtained at http://www.akc.org/reg/dogreg_stats.cfm), according to a recent survey by the American Kennel Association (AKC). No dogs from the AKC's top ten list were found in the lower ranking cluster. Several variables including color, markings, size and facial expression of the dogs were also analyzed, but were not found to significantly influence ranking preferences.

3.4 Discussion

In order to detect more subtle differences between the three types of comparisons used in the previous experiment, statistical power was increased by increasing the total sample size. Similar to experiment 1, the results suggested significant differences in how the participants responded to varying degrees of symmetry between the pairs of dogs. It was found that 56% of the participants found higher levels of facial symmetry more attractive than the more asymmetrical faces, which was consistent with Hypothesis 1.

Unlike the first experiment, support was found for hypothesis 2. Asymmetrical differences between pairs of dogs did affect preferences for higher levels symmetry with participants preferring the more symmetrical photos 60% of the time in the A/P comparison, 55% of the time in the N/A comparison, and 53% in the P/N comparison. The results indicated a trend for choosing the more symmetrical photo, and that it varied as a function of the magnitude of differences in the symmetry. These results are consistent with those found in the Rhodes et al. (1998) study. It is important to note that though the results suggest participants were having a more difficult time detecting smaller difference in symmetry, the facial manipulations only made subtle changes to the overall symmetry. To show how close the average symmetry of each of the three conditions actually were, when compared to the perfectly symmetrical condition the average symmetry of the normal or unaltered condition only deviated by 3%.

The binomial test confirmed that although participants were having difficult time detecting small differences in symmetry, they still preferred the more symmetrical photos in each comparison above chance levels.

Finally, the result of the cluster analysis indicated a two cluster solution. Further analysis suggested that the dogs in each cluster varied significantly from each other by their rank ordered scores. Specifically, cluster 1 had the highest ranking dogs and cluster 2 had the lowest ranking dogs. The data however, did not provide additional support for the first hypothesis that level of symmetry would be associated with perceived attractiveness. The results suggested that the natural variations in symmetry did not have a significant influence on the participant's perceptions of attractiveness when ranking the dogs.

While preferences for color, size, and facial expression did not seem to influence the dogs cluster membership, the results suggested that breed type did have a significant effect on cluster membership. After reviewing the both clusters it was also found that the majority of dogs in the highest ranking cluster had made the AKC's top ten list of breeds in the 50 largest U.S. cities. This suggests that the type of breed might have had an influence on how the participants ranked the dogs from favorite to least favorite. Unlike, the first experiment the popularity of the breed seemed to have more of an influence than whether or not the dog was seen as potentially aggressive.

Even as modifications were made to procedures in experiment 2, the results remained consistent with the first experiment. Experiment 1 was presented to the entire class using a PowerPoint presentation, which allowed the participants to view the pairs of dogs the full 7 seconds. Participants in experiment 2; however, viewed the presentation individually and had software that allowed the participants to move to the next slide once a preference was determined. It is interesting to note that even though participants in experiment 1 were given the opportunity to view the pairs longer than the participants in experiment 2, the results were similar in both experiments. Compared to experiment 1, participants took on average 0.247 seconds to determine preferences.

Because the results of experiment 1 and 2 suggested that participants did perceive higher levels of symmetry as more attractive, we proceeded in the next experiment to evaluate the hypothesis that dog breeders would prefer higher levels of symmetry overall compared to non-dog breeders.

CHAPTER 4

EXPERIMENT THREE

4.1 Methods

4.1.1 Participants

One hundred and fifty-one dog breeders and handlers were recruited between July 17 and July 20, 2008 from the Reliant Park World Series of Dog Shows at Reliant Center in Houston, Texas. Two participants were excluded from the data analysis for missing data, nine for not following instructions, and seven for suspicion of manipulations. In addition, 10 more potential participants were excluded for being under the age of the 18, leaving 123 participants for analysis. There were 22 males and 101 females ranging in age from 18 to 78 years old (M =. 50.51; SD = 12.07, see Table C.11). A booth was set up between the breed judging area and where the exhibitors prepped their dogs for the ring. Those who agreed to participate were asked to sign a consent form and directed to one of the six computers used to collect the data. The experiment was strictly voluntary and participants were offered no compensation for their participation. The experiment took less than 15 minutes to complete.

4.1.2 Stimuli

The 20 dogs used in the first two experiments were presented in a similar fashion to the non-dog breeders in the second experiment.

4.1.3 Design and Procedure

During the dog show, six computers were set up in a high traffic area in the Reliant arena. Flyers were passed out to exhibitors in the crating area as well as at the information desk located in the middle of the Reliant center. A 3 x 10 banner (near the booth) was used to indicate that individuals had the option of taking part in an experiment designed to assess facial attractiveness of dogs. The dog breeders viewed the same presentation as the non-dog breeders and were given similar instructions.

4.2 Data analysis

In order to compare the responses of the dog breeders to the non-dog breeders in second experiment, the hypotheses and data analysis performed in experiment 1 and 2 were used. Again, we expected participants would prefer more symmetrical faces when given a choice between pairs of dogs with varying symmetry. We also expected that the preferences would strengthen as the levels of symmetry increased. Specifically, the strongest preference would be for the asymmetrical/perfectly symmetrical comparison (A/P), then the normal/asymmetrical (N/A) comparison followed by the perfectly symmetrical/normal (P/N) comparison.

The results of the third experiment were then compared to the results of second experiment in order to provide support for the third hypothesis, dog breeders compared to non-dog breeders would prefer higher levels of symmetry overall and their preferences would strengthen significantly more as asymmetrical difference between the pairs increased. An independent t-test was used to test whether the differences in preference between dog breeders and non-dog breeders were above chance levels.

Finally, a hierarchical cluster analysis again was used to identify groups of dogs based on their rank ordered scores.

4.3 Results

The first hypothesis predicted that participants would find more symmetrical faces most attractive when given a choice between two faces with varying degrees of symmetry. A chi-square goodness of fit was used to test the prediction. The analysis confirmed that the preference for more or less symmetry was not equally distributed among the sample, $\chi^2(1, N = 7380) = 63.40$, $p < .001$. It was found that 55% of the participants perceived more symmetrical faces as the most attractive. An assessment of whether symmetry preferences strengthened across the three comparisons, however, yielded a non significant association between symmetry and perceived attractiveness ($\chi^2(2, N = 7380) = 4.83, p = .09$). Dog breeders preferred the more symmetrical photos 56% of the time in the A/P comparison, 53% of the time in the N/A comparison, and 55% in the P/N comparison, indicating the data did not support hypothesis 2 (see Figure B.6). The results also suggest a lack of support for third hypothesis that dog breeders would prefer higher levels of symmetry overall compared to non-dog breeders and their preferences would strengthen significantly more as asymmetrical difference between the pairs increased.

While there were no significant differences across the three types of comparisons, there were differences in the way dog breeders responded to the three comparisons when compared to non-dog breeders Unlike non-dog breeders, whose preferences increased across the three conditions, dog breeders had less difficulty detecting symmetry differences in the A/P comparison (the pair with the largest difference in symmetry) and the P/N comparison (the pair with the smallest difference in symmetry) than the N/A comparison (the pair with a moderate difference in symmetry).

The failure to find the predicted results led to a closer examination of the 20 dogs. Several analyses were used to assess the influence of variables on the participant's preferences including coat color, breed, size and markings. In these analyses only coat color (light, brown and dark) had significant results. A chi-square goodness of fit and test of independence were used to see whether preferences for more or less symmetry were significantly associated with attractiveness across the three types of comparisons, for all three color categories. The chi-square goodness of fit, for the light and medium colored dogs was significant, $\chi^2(1, N = 2583) = 13.25, p < .001$ and $\chi^2(1, N = 3690) = 80.20, p < .001$, indicating that preference for more or less symmetry was not equally distributed among the sample. Conversely, the chi-square goodness of fit for the dark colored dogs was not statistically significant, $\chi^2(1, N = 1107) = 1.83, p = .176$ suggesting there was insufficient evidence to determine preference for more or less symmetry. In fact, the dog breeders had a slightly stronger preference for the less symmetrical photos than the more symmetrical photos in the dark colored category. The chi-square test of independence, yielded a significant association between attractiveness and symmetry across the three levels of comparisons for the medium colored dogs, $\chi^2(2, N = 3690) = 19.69$, $p < .001$, but not the light colored dogs ($\chi^2(2, N = 2583) = .162$, $p = .92$). In the medium colored category, 60% of the dog breeders found the more symmetrical photo most attractive in the A/P comparison and the P/N comparison, while fewer dog breeders than expected (52%) found the more symmetrical photo in the N/A comparison more attractive. Though the results were significant, they were not in the predicted direction. The results again indicate that dog breeders were having a more difficult time with pairs of photos with moderate differences in symmetry than pairs with the smallest and the largest differences. In the light colored category, dog breeders preferred the more symmetrical dogs on average 54% of the time across the three comparisons, suggested that while they were significantly preferring more symmetry overall, however preferences did not strengthen with higher levels of symmetry.

Altogether, a binomial test confirmed that more symmetrical faces were significantly preferred by the dog breeders above chance levels in all three comparisons: the A/P (binomial test: $p < .001$, Table C.12) and N/A (binomial test: $p < .01$) comparison, and the P/N comparison (binomial test: $p < .001$). An independent t-test was then conducted to examine whether there were significant differences between the dog breeders and non-dog breeders results. The results indicated that there were no significant differences in symmetry preference between the non-dog breeders and the dog breeders, t (270) = 1.92, p = .06. That is, the average symmetry preference score of the dog breeders (M = .55, SD = .08) was not significantly different from that of non-dog breeders (M = .56, SD = .09).

Finally, another agglomerative hierarchical cluster analysis was used to categorize the ranked data from the dog breeders. The purpose of the analysis was to examine how the dogs were ranked by the dog breeders and to see if certain characteristics had a similar influence on their decisions. After examining the resulting dendrogram, it was determined that participants ranked the dogs in three distinct clusters (Figure B.7). Table C.13 provides a brief description of the dogs contained in each cluster. A one way ANOVA was then used to examine the group differences between clusters on measures of preference ratings. The means and standard deviations for each cluster can be seen in Table C.14. The assumption of equal variances on the preference ratings across the three clusters was satisfied. For the preference ratings, there was a significant difference between the clusters ($F(2, 17) = 48.17$, $p < .001$, $\eta^2 = .850$; Table C.15). The Tukey post-hoc comparisons revealed that all three means were significantly different from each other. Participants gave dogs in cluster 1 ($M = 8.23$) significantly higher preference ratings than cluster 2 ($M = 11.08$) and cluster 3 ($M = 14.60$). Dogs in cluster 2 also had significantly higher preference ratings than cluster 3.

A one way ANOVA was also used to examine the group differences between clusters on measures of calculated asymmetry. The means and standard deviations for each cluster can also be seen in Table C.14. The assumption of equal variances was satisfied. Similar to experiment 2, no significant differences were found between the clusters ($F(2, 17) = .013$, $p = .987$, Table C.16)

Additional analysis on the preference ratings included examining the influence of coat color, breed, size, markings and expression. The results suggested that no one variable stood out as the major influence in how the dogs were ranked.

4.4 Discussion

There were three general goals to this experiment. The first two goals were to see if dog breeders would prefer higher degrees of facial symmetry and to see if their preferences would strengthen as asymmetrical differences increased between the pairs of dogs. The final goal was made with the assumption of a functional component to a dog breeder's assessment of attractiveness. The question posed was would dog breeders, compared to non-dog breeders, have a higher preference for symmetry, overall as well as across the three types of comparisons. The data suggested that while dog breeders could detect subtle differences in symmetry, the preferences for more symmetrical faces did not strengthen as asymmetrical differences between the pairs increased. Furthermore the data did not support the third hypothesis that dog breeders, when compared to non-dog breeders, would have higher symmetry preferences overall and across the three comparisons. Dog breeders and non-dog breeders were both found to have similar symmetry preferences with the former preferring symmetrical photos 55% of the time and the latter preferring it 56%. This then begs the question, why didn't the dog breeders follow the predicted pattern.

When the dogs were analyzed individually it was found that preferences were highly varied. Further analysis showed that the dog's coat color also influenced their response patterns. When the dogs were grouped by color the results suggested that dog breeders were having difficulty distinguishing differences between pairs of dogs with light and dark colored coats. After reviewing the dogs in each group, it seemed that the reasons for their difficulties were different for each group. The light colored group was made up of dogs that were either white or a very light crème. It is possible that the combination of quick reaction times and the dog's light color fur may have made it difficult to determine structure of the dog's faces. If landmarks were indistinguishable this could have made it more difficult to detect symmetry. This may also explain why the dog breeders preferences did not strengthen with the increase in asymmetrical differences in the pairs even though they did prefer more symmetry overall. The dark colored dogs seemed to have a different characteristic that hindered the dog breeder's ability to detect symmetry. A majority of the dark colored dogs had symmetrical coat markings. It is possible that the markings had a strong influence on the perception of facial structure making symmetrical differences negligible to the naked eye. The non-dog breeders were also found to have similar difficulties.

Another possible explanation for the dog breeder's results may be due to the decision processes they used. Compared to non-dog breeders, breeders use checklists when judging the quality of a dog. These lists can include specifications for structure, temperament and movement. Although not all specifications are always present when judging dogs, breeders are comparing the dogs against breed standards. It is possible that because the dogs were not show quality pure breeds and obviously temperament and movement were not observable; symmetry may have been the remaining quality to base their judgments on. This might explain why the dog breeders were better able to detect subtle differences between pairs with the smallest and largest difference, since both contained a perfectly symmetrical version of the dog. In regards to the N/A comparison there are two possible explanations for the results. First, when collecting the data, many participants expressed dissatisfaction with dogs chosen for the study suggesting they may have had a slight bias against the dogs used in the study. Their expressed dislike for the dogs coupled with lack of standard cues to base the quality of the dog on, might have made it difficult to prefer either dog in this comparison.

This assumption may also be used to explain why no evidence was found to support the biological bias assumption. Compared to assessing the attractiveness of other human beings, dog breeders make conscious decisions when breeding dogs for desired characteristics. As for the human studies, it has been suggested that these preferences may be driven by specialized mechanisms that are at an unconscious level (Little & Jones, 2006). It may be possible that consciously looking for specific characteristics may counteract natural abilities in selection processes.

Further support for this supposition was found when the manipulation checks were analyzed. Dog breeders were asked if it was difficult to tell if there were differences between the pairs of dogs. Those who did not find it difficult to detect differences found higher levels of symmetry more attractive 51% of the time. Those who found it difficult only sometimes preferred higher levels of symmetry 57% of the time. The results suggest that those who were consciously aware of the manipulations did worse than those who were not. Demand characteristics could explain these effects; however, in trying to discern the hypothesis they possibly came to the wrong conclusion. A generation of a different hypothesis could have sensitized them resulting in the present pattern of response.

As a side note there were some concerns about age effects in the experiment. Along with several complaints about the speed of the experiment, many of the older participants expressed concern regarding their lack of computer experience and their ability to complete the experiment. Age and symmetry preference were found to have a negative relationship ($r = -0.21$, $p = .05$), but the results suggest it was a weak relationship.

Finally, we also found that natural symmetry did not have a major influence on how the breeders ranked the dogs. After examining the three clusters that were produced by the hierarchical cluster analysis, it is possible that dog breeders may have considered the dogs in the highest ranking cluster closer to their breed standard than the dogs in the other 2 clusters. However, we were unable to discern specifically what influenced their ranking decisions.

4.5 General Discussion

The intention of this study was to explore whether the use of hetero-specifics would produce similar differential effects upon an individual's preferences for symmetry as the previous studies using conspecifics have found. As expected, dog breeders and non-dog breeders both found facial symmetry attractive providing further support for the association between facial symmetry and perceived attractiveness. Although the effect was less than those found in the human studies (Perrett, et al., 1999; Rhodes et al., 1998), we did find that the results were repeatable and statistically significant. Further, the results were significant without drastically manipulating the dog's faces. Only the non-dog breeders preferred higher levels of symmetry significantly more in each of the three types of comparisons. The results from dog breeders however were not in the expected direction (rejecting our biological bias assumption).

While coat color and decision-making processes may have had an influence on the breeders and non breeder's responses, there may have also been other variables influencing the results. First, there was some concern about the inability to control outside influences in the environment at the dog show. Unlike the non-dog breeders, who are were in a controlled environment at the University, the dog breeders participated in the experiment at a busy arena and in between showing their animals. The concern was whether the lighting and the hectic surroundings were distracting for the breeders. Although we were placed in an area off to the side of the events, it would have been ideal to have an isolated area from which to conduct the experiment.

4.5.1 Limitations

Basic human relationships with dogs has spanned for over 10,000 years (Vila, Savolainen, Maldonado, Amorim, Rice, Honeycutt, Crandall, Lundeberg & Wayne, 1997). By living in such close proximity humans may have become more sensitive to their varying degrees of symmetry. However, there are some limitations to using this species. One concern was the lack of distinctive secondary sexual characteristics observable in dogs (though it is important to note the distinction between the sexes may be more pronounced in some breeds more than others). Recent studies have shown that when compared to ordinary morphological traits, secondary sexual characteristics often exhibit higher degrees of fluctuating asymmetry (Møller and Pomiankowski, 1993). These secondary characteristics are often specific to a sex and due to the fact that increases in sexual dimorphism make these characteristics more pronounced, there was some concern about the minimal gender differences in dogs. During the domestication process, breeders minimized the differences between dog's sexually dimorphic characteristics that are typically seen in their wolf ancestors (Zeder, 2006). Due to the selective breeding, dogs temperament changed (making them less aggressive and more juvenile in nature) which in turn made them more dependent on humans (Lindsay, 2000). In addition, with this prolonged juvenile state, juvenile behaviors (playfulness) and characteristics (shorter snout, floppy ears, curled tails and shorter legs) were retained. Zeder (2006) suggested that the "lessening of sexual dimorphism" was linked with these behavioral and morphological changes.

Though records of castrations were not recorded, the possibility of using castrated dogs in the study may have also been a limitation of the study. It has been suggested that spaying or neutering dogs will halt the development of these secondary sexual characteristics. Again, because these characteristics express a greater magnitude of fluctuating asymmetry than other morphological traits, it is possible that cues of quality were more difficult to assess in the normal or unaltered photos of castrated dogs.

There might be some questions about the dog breeder's results due to the fact that AKC standards prefer wider set eyes for a majority of the breeds. So, we decided to test whether or not the dog's eye width was a contributing factor in the dog breeder's preferences for the perfectly symmetrical faces. After recalculating the eye width of each dog, in all three conditions, it was found that 55% of the dogs had a wider eye set in the perfectly symmetrical condition compared to the other their two conditions. When breeder's preferences for symmetry were analyzed along with the differences in eye widths in the A/P and P/N comparisons, the results showed that there was an equal preference for the more symmetrical dog regardless of the whether the eyes were wider apart or not. This suggests that although eye width is important to breeders it was not a significant influence on their preferences.

4.5.2 Future Studies

Preferences for symmetry might be strengthened if more sexually dimorphic animals (those that differ in size and color; e.g. lion, red deer, elephant seals, fish, or birds) were utilized in this type of study. Comparing zoo animals (who obtain medical treatments and 24 hour observation) with wild animals may also lend further support for the assumption that symmetry may be a cue for quality. Compared to animals living in a zoo, wild animals may be more likely to encounter diseases or anomalies in development and without the medications to counteract the effects, the differences in overall symmetry may be more apparent

Another possible avenue would be to have the participants view pairs of photos that contain both human and non-human faces. This would provide a direct measure to see if preference for symmetry is not just relevant within one's own species (i.e. finding a potential mate) but also influential when assessing the attractiveness of hetero-specifics. If the strength of the preference were found to be similar in both cases, it would provide further support for the symmetry adaptation's ability to generalize.

APPENDIX A

QUESTIONAIRE FOR EXPERIMENT ONE

Questionnaire A.1

PART I

You will be presented with a number of paired dogs. For each pair you must identify which dog, at first impression, is more appealing. Though it might not appear so, there are slight differences within each pair. You will be given 7 seconds to select your preferred dog by checking either A or B. There are three groups of photos that you will evaluate. Each group will be separated by a number of questions. Please read the question and record how well the statement describes you. Before the experiment begins, you will be shown 3 test slides. This test will allow you to familiarize yourself with the format. Please record your response in space provided.

TEST Example 1. □ A □ B   Example 2. □ A □ B □ A   Example 3. □ A □ B

PART II

1. □ A □ B	21. □ A □ B	41. □ A □ B
2. □ A □ B	22. □ A □ B	42. □ A □ B
3. □ A □ B	23. □ A □ B	43. □ A □ B
4. □ A □ B	24. □ A □ B	44. □ A □ B
5. □ A □ B	25. □ A □ B	45. □ A □ B
6. □ A □ B	26. □ A □ B	46. □ A □ B
7. □ A □ B	27. □ A □ B	47. □ A □ B
8. □ A □ B	28. □ A □ B	48. □ A □ B
9. □ A □ B	29. □ A □ B	49. □ A □ B
10. □ A □ B	30. □ A □ B	50. □ A □ B
11. □ A □ B	31. □ A □ B	51. □ A □ B
12. □ A □ B	32. □ A □ B	52. □ A □ B
13. □ A □ B	33. □ A □ B	53. □ A □ B
14. □ A □ B	34. □ A □ B	54. □ A □ B
15. □ A □ B	35. □ A □ B	55. □ A □ B
16. □ A □ B	36. □ A □ B	56. □ A □ B
17. □ A □ B	37. □ A □ B	57. □ A □ B
18. □ A □ B	38. □ A □ B	58. □ A □ B
19. □ A □ B	39. □ A □ B	59. □ A □ B
20. □ A □ B	40. □ A □ B	60. □ A □ B

Break

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1.	□	□	□	□	□
2.	□	□	□	□	□
3.	□	□	□	□	□

Break

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agre
4.	□	□	□	□	□
5.	□	□	□	□	□
6.	□	□	□	□	□

PART III

Now, please put the following dogs in order from favorite to least favorite.

Dog 1 ____Dog 2 ____ Dog 3 ____
Dog 4 ____Dog 5 ____ Dog 6 ____
Dog 7 ____Dog 8 ____ Dog 9 ____
Dog10 ____Dog11 ____ Dog 12____
Dog 13 ___ Dog 14 ____Dog 15____
Dog 16____Dog 17 ____Dog 18____
Dog 19 ___ Dog 20____

PART IV

Sex: □ Male □ Female
Age: ______
Do you have any pets? □ Yes □ No

If yes, do you have a dog? □ Yes □ No

Relationship Status:
□ Single □ Dating □ Married

Are or have you been a dog breeder?
□ Yes □ No

APPENDIX B

FIGURES

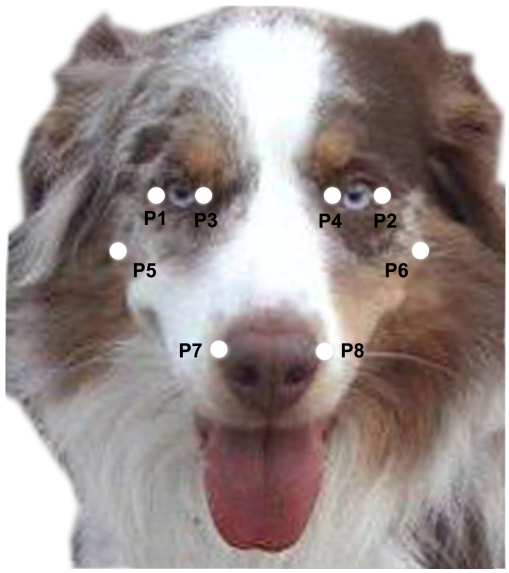

Figure B.1 Facial Landmarks used in calculating asymmetry.

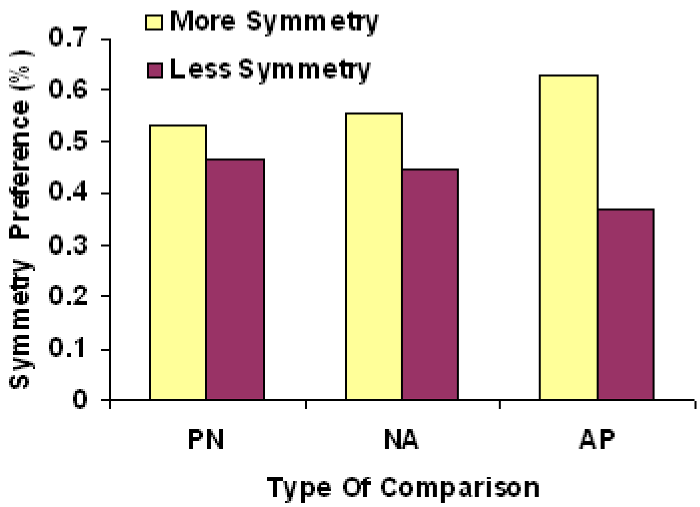

Figure B.2. Experiment 1: Proportions of symmetry preference from the three types of symmetry comparisons

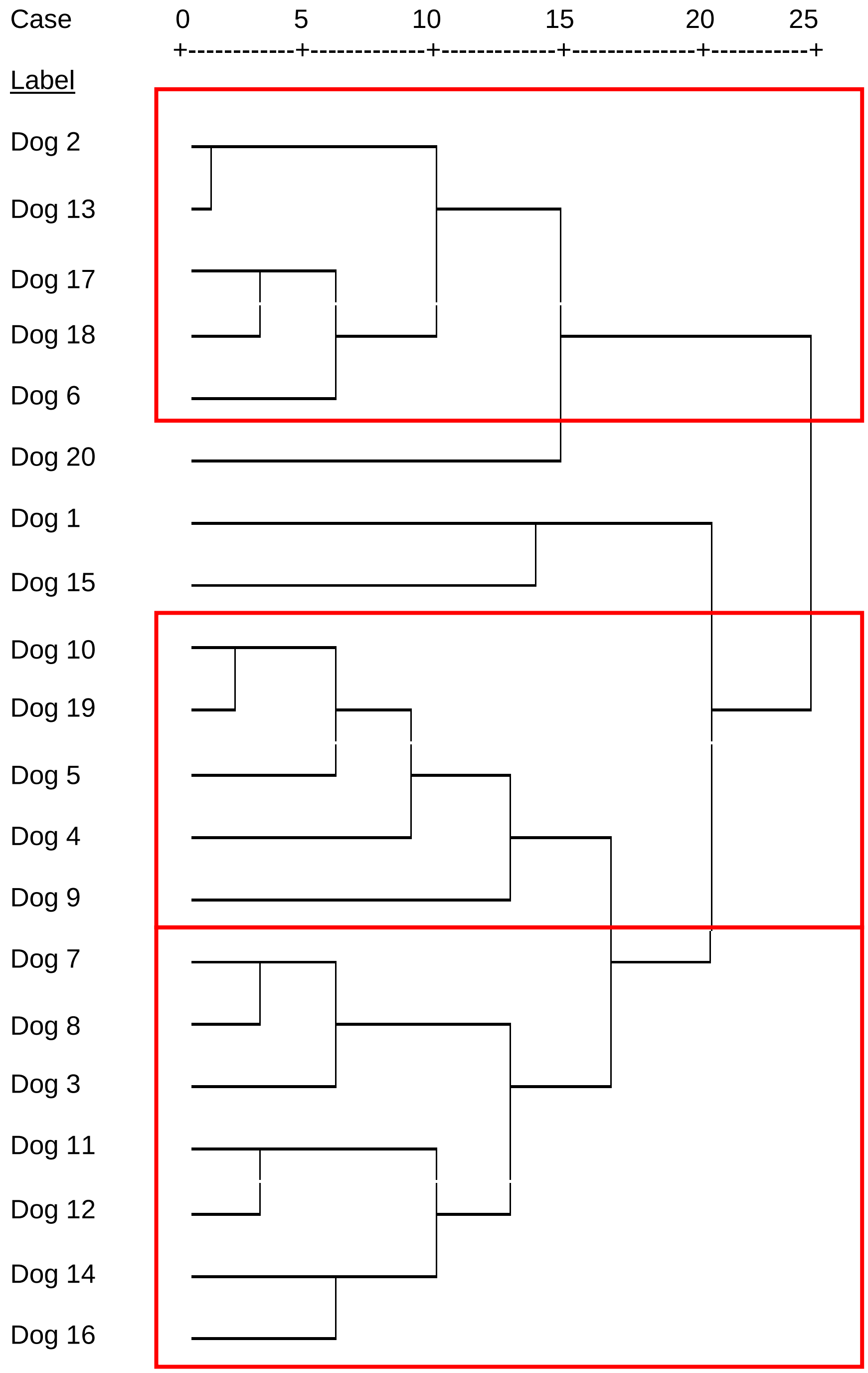

Figure B.3. Experiment 1: Dendrogram using Average Linkage. The three boxes identify the three remaining clusters used in the analysis. The first box from the top contains all of the dogs in Cluster 1, the second box contains all the dogs in Cluster 3, and the final box contains all of the dogs in Cluster 2

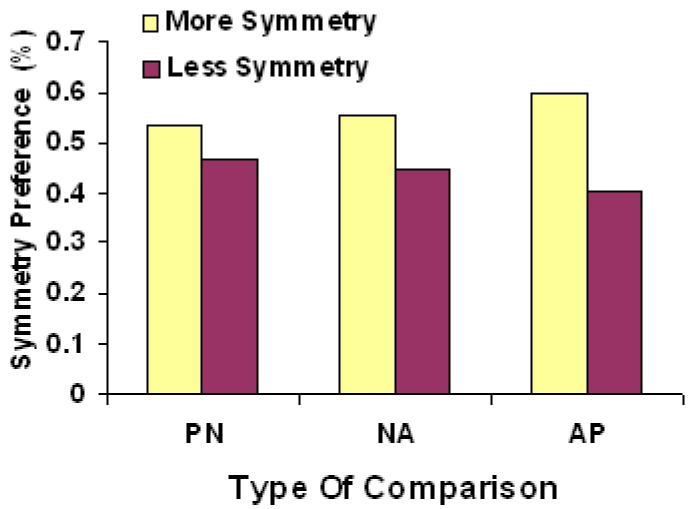

Figure B.4. Experiment 2: Proportions of symmetry preference from the three types of symmetry comparisons

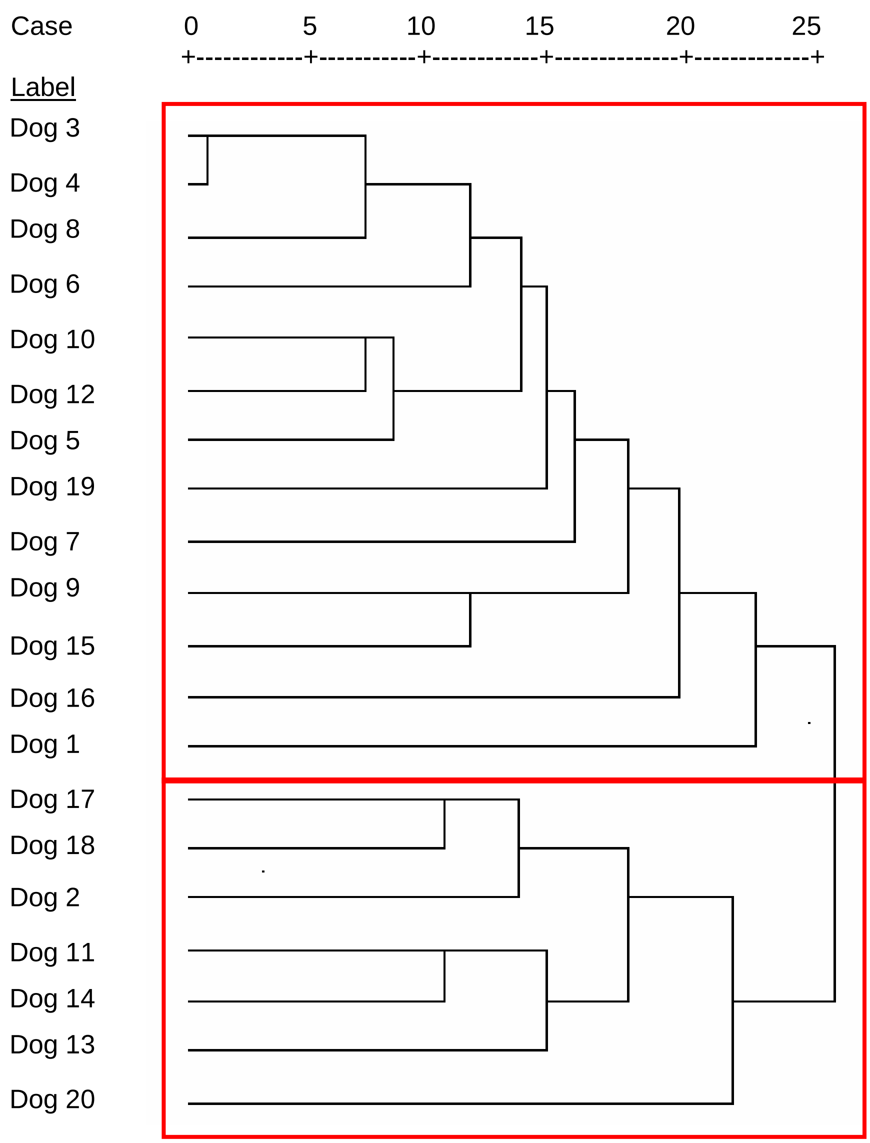

Figure B.5. Experiment 2: Dendrogram using Average Linkage. The two boxes identify the two clusters produced by the cluster analysis. The first box contains all of the dogs in Cluster 1 and the second box contains all of the dogs in Cluster 2

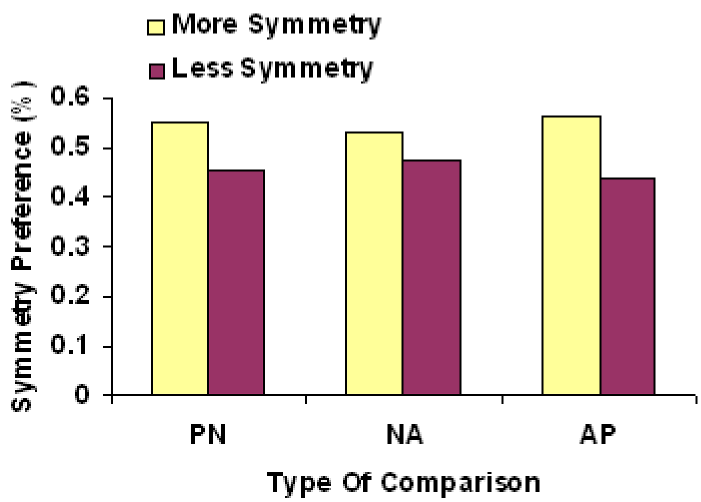

Figure B.6. Experiment 3: Proportions of symmetry preference from the three types of symmetry comparisons.

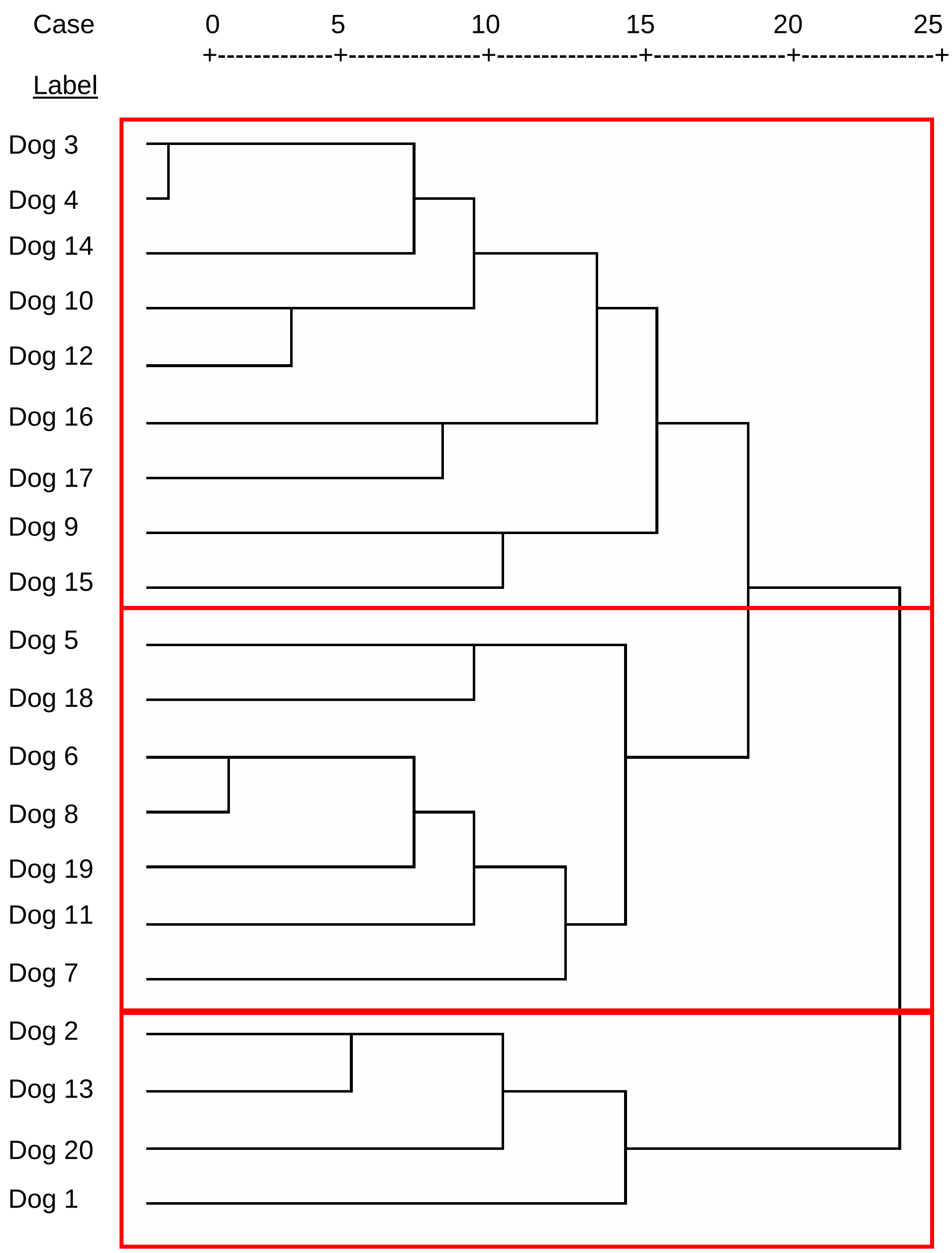

Figure B.7. Experiment 3: Dendrogram using Average Linkage. The two boxes identify the threw clusters produced by the cluster analysis. The first box contains all of the dogs in Cluster 1, the second box contains all of the dogs in Cluster 2 and the final box contains all of the dogs in Cluster 3.

APPENDIX C

TABLES

Table C.1. Experiment 1: Descriptive statistics for non-dog breeders (N-28)

Variables	Mean (N-28)	SD
Age	24.50	5.02

	Frequency	Percent
Gender		
Female	19	84.6%
Male	9	15.4%
Dog Ownership		
Yes	15	53.6%
No	13	46.4%
Relationship Status		
Single	13	46.4%
Dating	9	32.1%
Married	6	21.4%
Type of Symmetry Comparison		
Asymmetrical/Perfectly symmetrical	560	33.3%
Normal/Asymmetrical	560	33.3%
Perfectly symmetrical/Normal	560	33.3%
Level of Symmetry Preference		
More symmetry	963	57.3%
Less symmetry	717	42.7%

Table C.2. Experiment 1: Results of the binomial test for preferences in the three types of symmetry comparisons

Comparisons	Preferred Level of Symmetry (n)	Test Proportion	*p* value
Asymmetrical/Perfectly symmetrical			
More symmetrical	354	.50	.001[a]
Less symmetrical	206		
Normal/Asymmetrical			
More symmetrical	311	.50	.01[a]
Less symmetrical	249		
Perfectly symmetrical/Normal			
More symmetrical	298	.50	.139[a]
Less symmetrical	262		

Note. [a] Based on Z Approximation.

Table C.3. Experiment 1: Type of breed and age of all dogs in each cluster

Clusters	Dog label	Breed	Age
Cluster 1			
	2	Husky	Adult
	13	Australian Shepard	Adult
	17	Belgian Sheepdog	Adult
	18	Rottweiler	Adult
	6	Pit Bull	Adult
Cluster 2			
	7	Labrador Retriever	Adult
	8	Boxer	Adult
	3	Beagle/Basset Hound	Adult
	11	Australian Shepard	Adult
	12	Labrador Retriever	Adult
	14	Australian Shepard	Adult
	16	Terrier	Adult
Cluster 3			
	10	Golden Retriever	Adult
	19	Blue Heeler	Adult
	5	Labrador Retriever	Adult
	4	Beagle	Senior
	9	Terrier	Puppy

Note. A dog is considered a puppy if it less than a year old, an adult when it is between the ages of 1 and 8, and senior when is over the age of 8

Table C.4. Experiment 1: The means and standard deviations for each cluster in terms of symmetry and rank order means as well as the breeds for each cluster

		Cluster 1 (n = 5)	Cluster 2 (n = 7)	Cluster 3 (n = 5)
Symmetry				
	M	.971	.960	.981
	SD	.015	.009	.008
Rank Order Scores				
	M	12.600	10.046	8.107
	SD	.983	.493	1.127

Note. Scores ranked from 1 to 20 (1 being favorite, 20 being lease favorite).
Two clusters removed due to small total numbers: Cluster 1 contained only 2 dogs, Cluster 5 contained only 1 dog

Table C.5. Experiment 1: Analysis of variance for preference ratings

Source	SS	*df*	*MS*	*F*	*p*
Between	50.854	2	25.427	34.239	.001
Within	10.397	14	.743		
Total	61.251	16			

Table C.6. Experiment 1: Analysis of variance for measures of symmetry

Source	SS	*df*	*MS*	*F*	*p*
Between	.001	2	.001	5.610	.05
Within	.002	14	.000		
Total	.003	16			

Table C.7. Experiment 2: Descriptive statistics for non-dog breeders (N-149)

Variables	Mean (N-149)	SD
Age	20.42	3.88

	Frequency	Percent
Gender		
Female	112	75.2%
Male	37	24.8%
Dog Ownership		
Yes	72	48.3%
No	77	51.7%
Relationship Status		
Single	77	51.7%
Dating	65	43.6%
Married	6	4.0%
Divorced	1	0.7%
Type of Symmetry Comparison		
Asymmetrical/Perfectly symmetrical	2980	33.3%
Normal /Asymmetrical	2980	33.3%
Perfectly symmetrical/Normal	2980	33.3%
Level of Symmetry Preference		
More symmetry	5018	56.1%
Less symmetry	3922	43.9%

Table C.8. Experiment 2: Results of the binomial test for preferences in the three types of symmetry comparisons

Comparisons	Preferred Level of Symmetry (n)	Test Proportion	*p* value
Asymmetrical/Perfectly symmetrical			
More symmetrical	1783	.50	.001[a]
Less symmetrical	1197		
Normal/Asymmetrical			
More symmetrical	1643	.50	.001[a]
Less symmetrical	1337		
Perfectly symmetrical/Normal			
More symmetrical	1592	.50	.001[a]
Less symmetrical	1388		

Note. [a] Based on Z Approximation.

Table C.9. Experiment 2: Type of breed and age of all dogs in each cluster

Clusters	Dog label	Breed	Age
Cluster 1			
	3	Beagle/Basset Hound	Adult
	4	Beagle	Senior
	8	Boxer	Adult
	6	Pit Bull	Adult
	10	Golden Retriever	Adult
	12	Labrador Retriever	Adult
	5	Labrador Retriever	Adult
	19	Blue Heeler	Adult
	7	Labrador Retriever	Adult
	9	Terrier	Puppy
	15	Chihuahua	Puppy
	16	Terrier	Adult
	1	Pit Bull	Puppy
Cluster 2			
	17	Belgian Sheepdog	Adult
	18	Rottweiler	Adult
	2	Husky	Adult
	11	Australian Shepard	Adult
	14	Australian Shepard	Adult
	13	Australian Shepard	Adult
	20	Basset Hound	Adult

Note. A dog is considered a puppy if it is less than a year old, an adult when it is between the ages of 1 and 8, and senior when over the age of 8.

Table C.10. Experiment 2: The means and standard deviations for each cluster in terms of symmetry and rank order means as well as the breeds for each cluster

		Cluster 1 (n = 13)	Cluster 2 (n=7)
Symmetry			
	M	.968	.970
	SD	.013	.013
Rank Order Scores			
	M	9.176	12.960
	SD	2.267	2.601

Note. Scores ranked from 1 to 20 (1 being favorite, 20 being lease favorite).
Two clusters removed due to small total numbers: Cluster 1 contained only 2 dogs, Cluster 5 contained only 1 dog.

Table C.11. Experiment 3: Descriptive statistics for dog breeders (N-123)

Variables	Mean (N-123)	SD
Age	50.51	12.07

	Frequency	Percent
Gender		
Female	101	82.1%
Male	22	17.9%
Dog Breeder/Handler status		
Breeder	99	80.5%
Handler	71	57.7%
Both	61	49.6%
Relationship Status		
Single	22	17.9%
Dating	9	7.3%
Married	74	60.2%
Divorced	13	10.6%
Widowed	5	4.1%
Type of Symmetry Comparison		
Asymmetrical/Perfectly symmetrical	2460	33.3%
Normal/Asymmetrical	2460	33.3%
Perfectly symmetrical/Normal	2460	33.3%
Level of Symmetry Preference		
More symmetry	4032	54.6%
Less symmetry	3348	45.4%

Table C.12. Experiment 3: Results of the binomial test for preferences in the three types of symmetry comparisons

Comparisons	Preferred Level of Symmetry (n)	Test Proportion	*p* value
Asymmetrical/Perfectly symmetrical			
More symmetrical	1379	.50	.001[a]
Less symmetrical	1081		
Normal/Asymmetrical			
More symmetrical	1303	.50	.01[a]
Less symmetrical	1157		
Perfectly symmetrical/ Normal			
More symmetrical	1350	.50	.001[a]
Less symmetrical	1110		

Note. [a] Based on Z Approximation.

Table C.13. Experiment 3: Type of breed and age of all dogs in each cluster

Clusters	Dog label	Breed	Age
Cluster 1	3	Beagle/Basset Hound	Adult
	4	Beagle	Senior
	14	Australian Shepard	Adult
	10	Golden Retriever	Adult
	12	Labrador Retriever	Adult
	16	Terrier	Adult
	17	Belgian Sheepdog	Adult
	9	Terrier	Puppy
	15	Chihuahua	Puppy
Cluster 2			
	5	Labrador Retriever	Adult
	18	Rottweiler	Adult
	6	Pit Bull	Adult
	8	Boxer	Adult
	19	Blue Heeler	Adult
	11	Australian Shepard	Adult
	7	Labrador Retriever	Adult
Cluster 3			
	2	Husky	Adult
	13	Australian Shepard	Adult
	20	Basset Hound	Adult
	1	Pit Bull	Puppy

Note. A dog is considered a puppy if it is less than a year old, an adult when it is between the ages of 1 and 8, and senior when over the age of 8.

Table C.14. Experiment 3: The means and standard deviations for each cluster in terms of symmetry and rank order means as well as the breeds for each cluster

		Cluster 1 (n = 9)	Cluster 2 (n = 7)	Cluster 3 (n=4)
Symmetry				
	M	.970	.970	.970
	SD	.015	.014	.008
Rank Order Scores				
	M	8.229	11.077	14.602
	SD	1.098	1.136	1.014

Note. Scores ranked from 1 to 20 (1 being favorite, 20 being lease favorite).
Two clusters removed due to small total numbers: Cluster 1 contained only 2 dogs, Cluster 5 contained only 1 dog.

Table C.15. Experiment 3: Analysis of variance for preference ratings

Source	*SS*	*df*	*MS*	*F*	*p*
Between	116.057	2	58.028	48.174	.001
Within	20.478	17	1.205		
Total	136.534	19			

Table C.16. Experiment 3: Analysis of variance for measures of symmetry

Source	*SS*	*df*	*MS*	*F*	*p*
Between	.001	2	.001	.013	.987
Within	.003	17	.001		
Total	.003	19			

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BIOGRAPHICAL INFORMATION

Deborah McArthur completed her Bachelor of Science in Psychology at Sam Houston State University in 1996. After graduation, she returned to obtain her secondary teaching certification in English. After a brief stint in advertising she decided to return to graduate school to pursue a career in animal behavior. Under the supervision of Dr. Roger Mellgren, Deborah received a Master's degree in Experimental Psychology. Deborah's interests lie in animal learning and behavior as well as evolution of behavior. Previous research has included: jealousy, facial symmetry and classical conditioning. She plans on continuing her research with Dr. Mellgren and completing her dissertation.