AN ABSTRACT OF THE THESIS OF

Lydia Njoroge for the Master of Science

in Experimental Psychology presented March 23rd, 2015

Title:

You stink so sexily: Sweaty T-shirts in Emporia

Abstract approved: [signature]

This study is a replication with a modification of the original work done by Claus Wedekind in 1995 who used participants' Major Histocompatibility Complex (MHC) type as a predictor of their mate selection patterns and found a significant negative relationship between MHC similarity and pleasantness of smell ($p = .03$). Females taking oral contraception did not show this pattern ($p = 0.34$). The present study looks at the dissimilarity of blood type, male physical fitness, and female perceptions of pleasantness and sexiness of male olfactory cues. I matched university athletes males with males who did not exercise on a regular basis (less than once a week). Female participants rated the attractiveness of one control shirt and ten experimental shirts I randomly selected from the twenty-two possible shirts the male participants wore. The results suggested athletes smelled stronger than non-athletes ($p < .001$), but that overall there were no preferential differences between blood types ($p > .05$). Possible explanations and confounds for these results, such as the activities completed while wearing the shirt are examined to understand the value of this data in the greater context of mating research.

Keywords: Sex, Mate-Selection, Olfactory Cue, MHC, HLA

YOU STINK SO SEXILY:

SWEATY T-SHIRTS IN EMPORIA

A Thesis

Presented to

the Department of Psychology

Emporia State University

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

By

Lydia Njoroge

March 2015

Approved for the Department of Psychology

Approved by the Dean of the Graduate School and Distance Education

ACKNOWLEDGEMENTS

I would like to thank my thesis committee for their help throughout this process, my family and friends for their support, and the participants who made this research possible.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

'Women are too picky.' – Anonymous

Robert Trivers (1972) would likely have agreed with this statement. His work focused on the mechanisms behind mate selection patterns and how they differed by sex. In his work from 1972, he outlines the minimum investment model which predicts that in sexually dimorphic species,[1] the sex that has the greater minimum investment required to produce offspring "will be more discriminating or selective…" (Buss, 2012, p. 108). This means that human females, who have a substantially higher level of minimum investment in their offspring than males, should be more selective about who they decide to take as a mate.

Genetic heterozygosity is one characteristic females should assess when selecting a mate. Having greater genetic diversity increases the reproductive fitness of her offspring. Wedekind, Seebeck, Bettens, & Paepke (1995) looked at preferences for heterozygosity in relation to the immune system. He did this by having female participants smell the shirts of males worn over the weekend. He then assessed the human leukocyte-associated antigen (HLA) type of the participants. His analysis of the data looked to see if there was a relationship between the different HLA types and preferences for certain shirts. His findings showed that there was a strong pattern for women not on birth control to select shirts that had been worn by men with highly dissimilar HLA types.

I replicated Wedekind's (Wedekind et al. 1995) study with a modification. As evolutionary biology research has boomed, new areas of interest have become more cogent. Ecological evolution, or eco evo, assesses the interplay between environmental factors and evolution. An example of an environmental factor that may influence mate selection (and thus evolutionary patterns of a species) is the physical fitness and health of a potential mate. I introduced a second independent variable to assess the value females place on physical fitness. I measured physical fitness as an ordinal variable and used it to group male participants based on their status as a university athlete (high physical fitness) or a non-athlete who does not exercise (low physical fitness). I averaged the ratings of each male's shirt twice. The first average was to create an overall score of sexiness (and each of the other dependent variables) per individual male and thus replicate Wedekind's (Wedekind et al., 1995) study. I then averaged the ratings by the fitness of the male to assess the relationship between physical fitness and mate preferences. These data provide insight into the following questions: 1) Does a male's physical fitness have olfactory cues, and, if so, 2) Do females prefer males with high physical fitness over males with low physical fitness?

Literature Review

Evolutionary psychology is a subfield of psychology that seeks to understand human behavior from an evolutionary perspective (Buss, 2012). This means that researchers using evolutionary theory are looking to see what behaviors would have increased the fitness of humans. Fitness can be obtained through a number of mechanisms and across an array of situations. In 1999, Buss published the first edition of *Evolutionary Psychology: The New Science of the Mind*, a textbook that brought together a disjointed body of research. This book has clarified both the nature and expansiveness of evolution psychology research. In this context, Buss' textbook functions as a primary source. Buss (2012) presents four core areas of research for evolutionary psychology:

problems of survival, problems of group living, challenges of parenting and kinship, and challenges of sex and mating. As this is the seminal textbook for the field of evolutionary psychology, I have used it as a guide in presenting the major findings of each area as they relate to this research.

Researchers who assess survival focus on behaviors that aid in basic survival such as food acquisition and acquire shelter (Buss, 2012). If you consider Maslow's hierarchy of needs (Maslow, 1943), the behaviors in this section address the bottom two levels: food and shelter. Food acquisition and preferences have been studied by various researchers (Rozin, 1996; Rozin & Schull, 1988; Tierson, Olsen, & Hook,1985; Tooby & DeVore, 1987). As the climate humans inhabit increases in temperature, so does the amount of spices used in the food (Sherman & Flaxman, 2001). Their results suggest that there is an indirect relationship between geographic location and food preferences. Over time, humans of a given geographic location developed a preference for food prepared in accordance with the local tradition. Researchers showed that this preference was likely influenced by the prevalence of parasites and microorganisms (Billing & Sherman, 1998; Sherman & Flaxman, 2001). In Thailand's climate, there is a greater prevalence of parasites than in the areas inhabited by people like the Inuit (Sherman & Flaxman, 2001). The spices used to preserve food kept food safe to eat for a longer period of time in warmer climates. In cold climates, parasites are not as prevalent or hardy, and meat, for example, was preserved by the weather. There was no pressure to find additional ways to preserve food in cold climates.

The Embryo Protection Hypothesis is a similar concept about food preferences (Brandes, 1976; Fessler, 2002; Profet, 1992; Tierson, Olsen, & Hook, 1985). Tierson, Olsen, and Hook (1985) found that women who are pregnant tend to share similar aversions to food. The foods that women are averse to change throughout the pregnancy. The most common aversions focus on food that would have been high-risk foods during human evolution. A common example of this is meat. While it was a calorically intense food, it posed a great deal of risk if not prepared correctly. In their study of over 400 women, only three reported an aversion to bread and none of the women reported aversions to cereals. Breads and grains posed lower risk of food related illness and had signs that were more easily identifiable that it was not safe to eat than meat (Tierson, Olsen, & Hook, 1985).

Food is still an important topic for researchers who assess evolution in the context of living in a group (Buss, 2003). With the amount of effort and danger involved in food acquisition, it is a reasonable question to ask why a person would ever share. Altruism and cooperation offer increased reproductive fitness in two ways: helping others means there is a greater chance that there will be others to provide help later to the original helper (the theory of reciprocal altruism) and helping those related to the helper means that there is an increased chance of survival of the genes of the helpers (Axelrod, 1984; Axelrod & Hamilton, 1981; Cosmides & Tooby, 1992; Trivers 1971; Williams, 1966). The second point will be clarified in the following section on parenting and kinship.

Scholars interested in group living also investigate how investing in others increases the fitness of the investor (Alexander, 1979; Axelrod, 1984; Axelrod & Hamilton, 1981; Cosmides & Tooby, 1992; Trivers 1971; Williams, 1966). The basic idea of the reciprocal altruism theory is that it is beneficial to have others around to provide help. An example is a hunting party that kills an animal that has enough meat to feed the party and their families. If there is meat to spare that cannot be preserved, then it is a sound investment to use the meat to feed other members of a hunter's community. By feeding other members of the community, the original hunters increase access to people who will be more able to help them with a future hunt, help protect the community, provide social capital during disputes, or gain sexual favors.

There are many different examples of altruism that puts the helper at risk. Squirrels regularly engage in an alarm call when a predator or threat is spotted (Sherman, 1985). This puts the calling squirrel at increased risk of being injured or killed. This behavior does not make sense until considered the structure of a colony of squirrels. Squirrels tend to stay in groups of highly related individuals. This means that while a single squirrel might die sounding a warning call, the likelihood of 'alarm-sounding-genes' being passed on to the next generation are good.

While some humans have used altruistic behaviors to obtain fitness, humans have a unique level of intraspecies violence and warfare. Chimpanzees, a species that is closely related to humans, are one of the only other species known to actively take part in 'open warfare' (Andry, 1966; Wranfham & Peterson, 1996). Buss (2012) cites various works by Daly and Wilson (Daly & Wilson, 1994, 1996; Daly, Wilson, & Weghorst, 1982; Wilson & Daly, 1985, 1993, 1996; Wilson, Johnson, & Daly, 1995) that assess the value and type of violence commonly observed in human societies. Daly and Wilson's body of work is summarized with two points: 1) males tend to be more physically aggressive, while females tend to be more socially aggressive, and 2) males, more often than females, use aggression as a deterrent, especially in cases where they perceive the behavior of their mate may lead to infidelity. Physical aggression in modern society is socially reprehensible, but from an evolutionary perspective it was an effective tool to prevent cuckoldry (Daly & Wilson 1988, 1994, 1996; Daly, Wilson, & Weghorst, 1982; Wilson & Daly, 1993, 1996; Wilson, Johnson, & Daly, 1995).

Some of the problems of aggression are mediated by living in communities with kin. Having family and living near family were described by Buss (2012) as key ways to deter physical aggression. When family becomes a commodity and resource, it has to be operationalized in a way that facilitates measurement in research. Typically this is done by assessing genetic relatedness (Alexander, 1979; Daly & Wilson, 1988; Flinn, 1988). As genetic relatedness increases, the reward for helping another person also increases. This means that altruistic behaviors towards people who are genetically related to the helper may be less altruistic and more selfish. When given the choice of two people to help, an evolutionary psychologist would always bet on the person with the greatest amount of genetic relatedness to the helper when all other things are equal (Burnstein, Crandall, & Kitayama, 1994). The reason for this was alluded to in the squirrel example. When organisms help siblings, they are helping an organism that is up to 100% genetically similar if they have the same parents. The probability of their genes being passed on to the next generation is greater than if they helped a cousin or half sibling. A half sibling is only capable of up to 50% genetic relatedness and a cousin can only be (up to) 25% (Buss, 2012).

Parental investment in offspring is another heavily studied area of parenting and kinship (Trivers, 1972). Trivers is one of the foremost scholars in this area. His work in evolutionary biology helped scholars understand another potential source of conflict between sexually reproducing species. In sexually reproducing species, typically one sex will have a higher level of minimum investment than the other. This means that one sex has to commit more resources to produce offspring. In the case of humans, women have to go through gestation in order to produce offspring. Copulation is the only requirement for human males to reproduce. Trivers suggests that the sex that has the higher level of minimum investment will be more selective because the cost of selecting a 'bad' mate is greater. If a male takes a mate that is not healthy, he is only out the time it took to copulate. If a female takes an unhealthy mate, she loses the time during gestation to produce better offspring. The comparison here is nine minutes versus nine months.

This difference between sexes leads to different mate acquisition styles (Haselton, Buss, Oubid, & Angleitner, 2005). Mate acquisition research is typically divided into two sections based on sex and then further divided by long-term versus short-term mating strategies.

Male mating strategies have been thoroughly researched (Buss, 2003). The findings in this field suggest that human males have evolved to pick up a variety of cues about a woman's health, fertility, and ovulation cycle (Buss, 1989, 2012; Rosenblatt, 1974; Symons, 1979, 1995). These mechanisms are suspected to have come about as human females do not have explicit signals communicating their readiness to mate compared to females of other species of animals. Buss (2012) goes on to describe the costs and benefits of long-term and short-term mating. When a male takes a long-term mate, he is giving up additional opportunities to father children with other women. The benefit of a long-term mate is that there is less chance of cuckolding and a greater chance of the offspring from that pairing surviving and reproducing. The opposite is true of short-term mating. Males employing a short-term mating strategy are effectively playing an odds game that one of their numerous offspring will survive to reproduce.

Female mating strategies seem to suggest that females are only concerned with the resources a potential mate can provide, regardless of mating strategy (Hrdy, 1981; Smith, 1984; Smuts, 1985; Symons, 1979). There are a few instances, such as extramarital pairing, where research suggests that women look for qualities beyond ability and willingness to provide resources (Greiling, 1995; Greiling & Buss, 2000). Until recently, there has been a high level of consensus among academics that females are looking for resources and not biological cues (Eastwick, Neff, Finkel, Luchies, & Hunt, 2014; Meltzer, McNulty, Jackson, & Karney, 2013).

With the advancements in technology and biology, scholars are able to look at new and different potential cues (Hendrick, 1994; Gilbert, Yamazaki, Beauchamp, & Thomas, 1986; Hughes & Nei, 1989; Potts & Wakeland, 1993). One example of this type of research is the Sweaty T-shirt study (Wedekind et al., 1995). This team of researchers found that women showed a significant preference for shirts worn by men with dissimilar immune systems. This study has been and continues to be replicated with results suggesting that females are sensitive to olfactory cues. These findings suggest that females may, in fact, be using biological cues to assess a potential mate, just not the same ones that men are using. The original Sweaty T-shirt study (Wedekind et al., 1995) used a combination of evolutionary biology, immunology, and comparative psychology to producing groundbreaking results.

"Immunology is the study of the physiological mechanisms that humans and other animals use to defend their bodies from invasion by other organism (Parham, 2009, p.

1)." While there are three groups of mechanisms (physical barriers, innate immunity, and adaptive immunity), one type of mechanism in particular is of interest: adaptive immunity. The process of adaptive immunity entails specific cells gaining the ability to recognize and bind to pathogens through genetic manipulation (Parham, 2009). The effectiveness of this process is determined by the genetic makeup of the individual and is thus highly variable (Parham, 2009).

The variability of individuals and their immune responses were especially problematic in the field of medicine. When patients needed transplants, it was not always sufficient to ask a family member to provide the needed material (Q&A on Living Donations, n.d.). The work to find a method to accurately and effectively find donors of biomaterial lead to the discovery of the Major Histocompatibility Complex (MHC). The MHC is "the site of genes that cause T cells to reject tissues transplanted from unrelated donors to recipients" (Parham, 2009, p. 145). These genes are located on the 6^{th} chromosome in humans and produce two types of MHC molecules: MHC I and MHC II. MHC I molecules are designed to bind with viral pathogens. MHC II molecules are designed to bind with bacterial pathogens. In humans, the MHC complex is referred to as the Human Leukocyte Antigen (HLA) Complex. This is because the MHC molecules of other animals react to components of red blood cells, whereas human's MHC molecules react to white blood cells.

Similar to the types of blood, there are types of MHC I and MHC II molecules. MHC I has six isotypes: HLA-A, HLA-B, HLA-C, HLA-E, HLA-F, and HLA-G. MHC II has five isotypes: HLA-DM, HLA-DO, HLA-DP, HLA-DQ, and HLA-DR (Parham, 2009). Researchers are still working on identifying various pseudogenes and alleles for each of the isotypes mentioned above (Mack et al., 2013). HLA typing is very costly due, in part, to the number of alleles that can present at each isotype. Table1 (Table of HLA alleles in each prevalence category, 2015) and Table 2 provide a description of where researchers are at in terms of what they have identified and how much they know they do not know. Table 2 comes from Mack et al. (2013) and documents the changes in knowledge of Common and Well-Documented (CWD) alleles from the 2007 publication (1.0.0) to the more recent publication (2.0.0).

When discerning a person's HLA types, it is important to remember that each person will have both HLA I and HLA II type molecules as part of the immune system (Parham, 2009). Individual isotypes have no bearing on or relation to blood type. Erikogule, Büyükdogan and Cora (2011) looked at the relationship between blood type and HLA type in humans. Their results ($p > .01$) were reported as not statistically significant because the researchers were using more rigorous standards typically associated with medical research. The researchers did not publish their Pearson coefficient and exact p-value, but the results could be statistically significant using the standards of traditional psychological research where any p-value less than .05 is statistically significant.

Since the discovery of the MHC and HLA complex, there has been a variety of research looking at its predictive value beyond its association with blood type (Adams, 2001; Archie et al., 2010; Hughes & Nei, 1989; Wedekind & Penn, 2000). The most common organisms used in MHC research are mice and humans (Hughes & Nei, 1989). Beyond these two organisms, there has been research on the MHC in non-human primates (chimpanzees and orangutans; Adams, 2001), rats (Wedekind & Penn, 2000),

Table 1

List of HLA Isotypes and Alleles

HLA Locus	# Common Alleles	% Common Alleles	# Well-Documented Alleles	% Well-Documented Alleles	# Rare Alleles	% Rare Alleles
A	68	3.4%	178	8.8%	145	21.5%
B	125	4.8%	242	9.3%	190	17.6%
C	44	2.8%	102	6.6%	77	21.4%
DRB1	79	6.8%	147	12.7%	133	22.7%
DRB3	5	8.6%	7	12.1%		
DRB4	6	40.0%	2	13.3%		
DRB5	5	25.0%	3	15.0%		
DQA1	15	31.9%	4	8.5%	9	26.5%
DQB1	22	12.5%	8	4.5%	26	28.9%
DPA1	6	17.6%	0	0.0%	4	14.8%
DP B1	40	28.8%	14	9.0%	29	22.7%
All Loci	415	5.3%	707	9.0%	613	20.6%

Note: Reproduce from Table of HLA alleles in each prevalence category [Table]. (2015, February 11). Retrieved from Wikipedia: en.m.wikipedia.org/wiki/Human_leukocyte _antigen

Table 1 (con't)

List of HLA Isotypes and Alleles

HLA Locus	# Very Rare Alleles	% Very Rare Alleles	% Alleles Categorized
A	280	41.6%	~75%
B	468	43.5%	~75%
C	154	42.8%	~74%
DRB1	206	35.2%	~77%
DRB3			~21%
DRB4			~53%
DRB5			~40%
DQA1	7	20.6%	~88%
DQB1	42	45.2%	~91%
DPA1	15	55.6%	~88%
DP B1	29	32.8%	~90%
All Loci	1214	40.8%	~76%

Note: Reproduce from Table of HLA alleles in each prevalence category [Table]. (2015, February 11). Retrieved from Wikipedia: en.m.wikipedia.org/wiki/Human_leukocyte _antigen

Table 2

Comparison of the CWD 1.0.0 and 2.0.0 Catalogues

Locus	Number of CWD 1.0.0 alleles	Number of CWD 2.0.0 alleles	Number of CWD 2.0.0 common alleles	Number of CWD 2.0.0 well-documented alleles	Number of alleles shared between CWD 1.0.0 and 2.0.0
A	130	246	68	178	123
B	245	367	125	242	235
C	81	146	44	102	77
DRB1	142	226	79	147	139
DRB3	14	12	5	7	9
DRB4	7	8	6	2	7
DRB5	8	8	5	3	8

Note. CWD, common and well-documented. Reproduced from Mack, S. J., Cano, P., Hollenbach, J.A., He J., Hurley, C. K., Middleton, D., Moraes, M. E., Pereira, S. E., Kempenich, J. H., Reed E. F., Setterholm, M., Smith, A. G., Tilanus, M. G., Torres, M., Varney, M. D., Voorter, C. E., Fischer, G. F., Fleischhauer, K., Goodridge, D., Klitz, W., Little, A. M., Maiers, M., Marsh, S. G., Müller, C. R., Noreen, H., Rozemuller, E. H., Sanchez-Mazas, A., Senitzer, D., Trachtenberg, E., & Fernandez-Vina, M. (2013). Common and well-documented HLA alleles: 2012 update to the CWD catalogue. *Tissue Antigens*, *81*(*4*), 194–203.

Table 2 (con't)

Comparison of the CWD 1.0.0 and 2.0.0 Catalogues

Locus	Number of CWD 1.0.0 alleles	Number of CWD 2.0.0 alleles	Number of CWD 2.0.0 common alleles	Number of CWD 2.0.0 well-documented alleles	Number of alleles shared between CWD 1.0.0 and 2.0.0
DQA1	16	19	15	4	16
DQB1	27	30	22	8	25
DPA1	0	6	6	0	0
DPB1	51	54	40	14	48
Total	721	1122	415	707	687

Note. CWD, common and well-documented. Reproduced from Mack, S. J., Cano, P., Hollenbach, J.A., He J., Hurley, C. K., Middleton, D., Moraes, M. E., Pereira, S. E., Kempenich, J. H., Reed E. F., Setterholm, M., Smith, A. G., Tilanus, M. G., Torres, M., Varney, M. D., Voorter, C. E., Fischer, G. F., Fleischhauer, K., Goodridge, D., Klitz, W., Little, A. M., Maiers, M., Marsh, S. G., Müller, C. R., Noreen, H., Rozemuller, E. H., Sanchez-Mazas, A., Senitzer, D., Trachtenberg, E., & Fernandez-Vina, M. (2013). Common and well-documented HLA alleles: 2012 update to the CWD catalogue. *Tissue Antigens*, *81*(*4*), 194–203 hamsters, rabbits, pigs, bovine, chickens (Hughes & Nei, 1989), and elephants (Archie et al., 2010).

One of the most prolific areas of MHC research has looked at the relationship between MHC types and mate preferences. Initial studies of this relationship used mice (Yamazaki et al., 1976; Yamazaki et al., 1979). As the number of studies showing a statistically significant relationship between MHC and mate preference increased, so did the types of organisms to which the model was applied. As the results from MHC/HLA research branched out to other organisms, it became very similar to work in Comparative Psychology. Comparative psychology assesses the similarity and differences between humans and non-human animals.

In 1995, Wedekind and his colleagues published the seminal study that looked at the aforementioned relationship in human. Female students ($n = 49$) smelled the t-shirt of male students ($n = 44$) after the shirts had been worn for two consecutive days. All participants were typed for their HLA-A, HLA-B, and HLA-DR alleles. Females were asked to rate six unique t-shirts on three measures that all ranged from 0-10, with five being neutral. The measures were intensity, pleasantness, and sexiness. Of the six shirts, three shirts were from men with similar HLA types and three from men with dissimilar HLA types. The results showed a significant positive relationship between pleasantness and sexiness ratings ($r = 0.85$, $p < .001$). The results from the main research question were not quite as clear cut. Women who were not taking oral contraceptives rated males with dissimilar HLA types as more attractive than those with similar HLA types (no statistics provided). Women who were taking oral contraception showed the opposite pattern, rating males with similar HLA types as more attractive than those with dissimilar

HLA types. It was suggested that this might be due to the fact that oral contraceptives mimic pregnancy. During pregnancy in mice, females tend to seek out "MHC-similar individuals for communal nesting" (Wedekind et al., 1995, p. 247). This is one possible explanation of the differences observed based on the use of oral contraception.

A review of the replications and follow-up studies was published in 2009 by Havlicek and Roberts. The two main additions the researchers made to Wedekind's original work (Wedekind et al., 1995) were assessing the influence of 1) facial attractiveness and 2) established couples. The results were inconsistent across the studies (Havlicek & Roberts, 2009). The authors point to methodological differences as one source of the discontinuity. One theme that was consistent throughout the studies was that oral contraceptives made a difference in the mate preference patterns of females.

In addition to increasing the genetic heterozygosity of offspring through selecting mates with dissimilar MHC types, females should also be searching for mates who can provide a variety of resources (Buss, 2012). Some of the characteristics that are suggested to be important to females when selecting a made include: "[T]heir physical prowess, athletic skills, ambition, industriousness, kindness, empathy, emotional stability, intelligence, social skills, sense of humor, kin network, and position in the status hierarchy" (Buss, 2012, p. 108). Of these different resources, two are of particular interest: physical prowess and athletic ability. The hypothesis is that a potential mate who has high levels of physical prowess and/or athletic ability would be more able to provide his mate and their offspring physical protection. This does not mean that he would be more *willing* to provide protection. Scholars have pointed out that it is important to differentiate between the ability to do an action versus willingness to do an action (Buss, 2012).

Herz and Cahill (1997) and Herz and Inzlicht (2002) used Likert scale questions to measure how much participants value visual and olfactory cues of potential mates. Their findings suggest that olfactory cues are rated as more important than visual cues for females. Their research reflects a current gap in the field. Evolutionary theory suggests that females should prefer mates with high fitness and that olfactory cues are important (Buss, 2003; Gilbert et al., 1986; Herz & Cahill, 1997; Herz & Inzlicht, 2002). There is a need for research that combines these two variables to examine the relationship between smell and physical fitness of a potential mate. More specifically, can women smell a difference between males with high physical fitness and low physical fitness? If so, do they prefer the scent of men with high levels of physical fitness to the scent of males with low physical fitness?

Research Questions and Hypotheses

1. Is there a relationship between the blood type of the participants and perceived pleasantness/sexiness of the males' scents? (Replication)
2. Is there a relationship between the physical fitness of the male and the perceived pleasantness/sexiness of his smell? (New variable)
3. Is there an interaction between the physical fitness of the male and the blood types of the participants in the female's perception of the pleasantness/sexiness of the males' scents?
4. Does being on hormonal birth control change the relationship between blood type similarity and pleasantness/sexiness ratings?

I numbered the hypotheses with the same number as the research question to which they correspond.

1. There will be a negative relationship between blood type and perceived pleasantness/sexiness of the males' scents. As blood type similarity decreases, the perceived attractiveness of the scents should increase.
2. There will be a positive relationship between physical fitness and the perceived pleasantness/sexiness of the males' scents. Males with high levels of physical fitness will be rated as more attractive than males with low levels of physical fitness.
3. There will be a slight interaction between blood type and physical fitness. Both fitness groups will decline in perceived attractiveness as blood type similarity increases, but the low physical fitness group will have a sharper decline than the high physical fitness group.
4. Women on hormonal birth control will show an inverted pattern of pleasantness/sexiness rating and blood type from females who are not on hormonal birth control.

METHOD

Participants

Participants served different functions based on their sex. The descriptions below follow that division.

Males. I recruited two groups of males for this study: one group of males with a high level of physical activity and one group of males with a low level of physical activity. The key variables on which I measured males were age, height, weight, BMI, and activity level. Age, height, weight, and BMI are interval level variables that I used to match the two groups of males with differing activity levels. I recruited university football players to compose the high level of activity group. I recruited students who were not university athletes and currently enrolled in a lower division psychology course to be in the low level of physical activity group.

I recruited the first group of approximately 10 males from the university football team via the strength and conditioning coach. Football players have a high level of physical fitness required by their position as a university athlete. The strength and conditioning coach selected the most physically fit males from the team for me to recruit. These males should represent the highest level of physical fitness. High levels of physical fitness should be highly desirable for females based on evolutionary theory. This theory suggests a primary resource females are interested in is protection.

I recruited the low physical activity group of male participants via the psychology research pool. Ideally, these males would match their athletic counterparts so that they differ from the athletic group exclusively on their activity level. To that end, the recruiting statement included information regarding the desired age, height, weight, and activity level of the participants who would compose the low physical fitness group. Activity level is the only one of those variables that was a requirement, rather than a recommendation. I defined low physical activity males in this research as males who exercised less than once a week.

Females. I recruited female participants via the psychology research pool. I included three exclusion criteria for female participants: 1) they must be able to smell, 2) be premenopausal, and 3) not have had a hysterectomy. They smelled the t-shirts provided by the male participants. In order to increase the number of data points, each female was presented with 10 randomly selected shirts to smell. Each female also smelled a control shirt that was not worn, bringing the total number of shirts they smelled to 11. No matching occurred between the female and male groups.

Materials

The following is a list and description of the materials that I used in the study. I have included a copy of the IRB (Appendix A), consent forms (Appendix B), recruitment statements (Appendix C), the surveys (Appendices D-H), male instructions (Appendix I), male package (Appendix J), maps for the participants (Appendix K), the floor plan and session diagrams (Appendix L), and blood collection and assessment tool (Appendix M).

T-shirts. I provided each male participant with a new, never worn 100% cotton t-shirt. The shirts varied in size to accommodate each participant's body type. Providing t-shirts that fit appropriately, as opposed to providing overly baggy, one-size fits all shirts, increased the amount of skin contact each participant had with the shirt. This enabled the shirts to absorb as much of each individual's scent as possible. I instructed male participants to wear the t-shirt continuously for two days before returning their shirts, without washing, to the researcher. I asked participants to return their shirts in the same Ziploc baggy in which they received them, but there was a very low compliance level. The majority of the shirts were stored in new Ziploc baggies.

Grooming products. I provided male participants with a bar of unscented soap for use during the two days that the males were wearing their t-shirts. This allowed the males to maintain their regular hygiene routines, without introducing new and/or varying scents into the study. I told them not to use any deodorant during the study during the briefing.

Containers. The shirt containers were replicas of those used by Wedekind et al. (1995). I used cardboard boxes and Ziploc baggies to store the worn t-shirts. A small, triangular hole in the lid allowed female participants to sniff the t-shirts while ensuring that female participants were unable to obtain any visuals cues from the stimuli.

There are no psychometric data assessing the validity or reliability available for any of the scales used in this study. I designed the matching scale and the male manipulation check for this study. I designed and updated my demographic scale for this study. The sexy scent scale is a combination of the original questions use by Wedekind et al. (1995) and items I added to create a more holistic view of female participants' ratings. Psychometric analyses of the scales would lend weight to the results, but are far beyond the scope of this project.

Matching scale. This scale asked five questions that I used to match male participants in this study. A copy of the scale has been included in Appendix D.

Demographics. This scale is an extended demographic survey developed by the author. I used it to assess any potential effects associated with race, SES, or other potential extraneous variables. The items in the scale are: DOB, age, race, sex, year in school, ethnicity, religion, student status, employment status, personal income, family income, personal education, mother's education, father's education, sexual orientation, living arrangement, number of siblings, number of people who live with you, and pet ownership. A copy of the scale has been included in Appendix E.

Relationship status assessment scale. This scale contains questions about participants' marital status and dating preferences. A copy of the scale has been include in Appendix F.

Sexy scent scale. I developed this scale based on the questions used in the original experiment done by Wedekind et al. (1995). In addition to the three core questions from Wedekind's scale (strength of smell, pleasantness of smell, and sexiness of smell), five behavioral questions have been added. A copy of the scale has been included in Appendix G.

Male manipulation check. This scale included seven yes-no questions that asked male participants which, if any, of the restrictions listed on the instruction sheet they violated. A copy of the scale has been include in Appendix H.

Blood typing. I used the medical protocol of the anatomy and physiology course taught at this university as described below. I used diabetic supplies to collect blood samples. I used a fresh thin lancet, an alcohol swab, and a Band-Aid for each participant. I instructed participants to select the finger they wanted pricked and to apply pressure to that finger to facilitate blood collection. I put on gloves, swabbed the finger they selected, pricked their finger with the lancet, and then had them place three drops of blood on the slide for analysis. Once they were done, they were offered an additional swab to clean off any excess blood and a Band-Aid. I added a drop of anti-sera to each drop of blood and then stirred with a toothpick. After approximately five minutes, I took photos of the slides so I could reevaluate the blood type assessment later. Appendix M contains photographs of all of the materials used in the blood collection process.

Procedure

I began recruiting male participants as soon as the study received IRB approval. I recruited male participants in two stages to facilitate matching between the two groups. I contacted the head coach of the university football team with a request to have 10-15 football players volunteer for this study. The strength and conditioning coach provided a list of 15 males to recruit for this study. As male participants declined to participate, the strength and conditioning coach added new players to my list of potential recruits until I had 12 players confirmed. These participants comprised the high physical fitness group. Each of these participants completed the matching scale so that I could use that information to recruit the second group of males.

I recruited the low physical fitness group through the psychology research pool. I expected that there would not be a sufficient number of non-white male students to match to the non-white participants in the first group as Emporia's student body has a low level of ethnic diversity outside of the athletic programs. University officials in the office of diversity agreed to help recruit non-white male participants for this study via email. As males agreed to participate in this study, I asked them to complete the matching scale. It provided me with information I needed to ensure the best matches, as well as their preferred size of t-shirt. Once I secured both groups of males, I collected relevant secondary data. Specifically, I collected the statistics for each of the football players who volunteered to participate in this study and convert those values into z-scores for analysis. I emailed the male participants a notification reminding them of the date that the study began and the materials they needed to bring with them to the briefing.

Female participant recruitment began at the same time as the low physical fitness group. I recruited female participants via the psychology research pool. A week prior and a day prior to the beginning of the research, I emailed participants a notification reminding them of their roles and responsibilities in this research. The email included two maps to where I conducted the research. During this process, I had one male request an earlier meeting time for the initial meeting.

On day one, I met with one male student during our schedule meeting time prior to the rest of the participants to issue him his instructions, materials, and collect his blood. I met with the rest of the male participants in the arranged room and briefed them on the rules and requirements of this study. I provided each participant with a package before I emailed a link to the demographics survey and relationship status assessment scale to the participants. The package contained a t-shirt of the appropriate size with a small identification mark on the inside of the bottom hem, a bar of unscented soap, and a list of the foods and behaviors to avoid while participating in the study (see Appendix I). While they were completing their survey, males went to the changing room to put on their shirt. Once they returned, they had their blood taken. After they provided their blood sample, I asked the participants if they had any questions or concerns. They were then free to leave.

On day three, I contacted the male participants via email to check-in with them. If the participants had any questions or concerns about the research, I addressed them and reminded them that their participation is voluntary. No participants asked any questions or raised any concerns. I included the information about the time and location of where to return the t-shirt to the next day. Lastly, I reminded them again that their participation remained voluntary and that they were not required to finish. I emailed female participants a reminder of their appointment times.

On the fourth day of this study, males came into the lab to drop off their shirts between 8am-10am. All of the males received an email at 8am with a link to the final survey and a reminder to bring an additional shirt to change into. Once the shirts were placed in a Ziploc baggie, I marked the shirt with the participants' initials. I replaced the initials on the with the shirt's official ID number once all the shirts were dropped off. This ensured that no male knew his shirt's ID number if he overheard female participants talking about the study. I set up 11 stations with laptops for participants to use to complete their final survey. Once each male was finished I gave him his gift certificate for a free pizza, thanked him, and told him he was done with the study. Two males from the low physical fitness group missed the 10am deadline, but turned their shirts in in time to be used for this study. One male who signed up for this study showed up to pick up his materials and start wearing his shirt shortly after 10am. I told him that the male participants had already completed their part of this study. After this student left, I finished setting up the room for the female participants. I included pictures of the setup in Appendix L.

In order to avoid cross contamination of smells, each shirt had its own box. I used a random number generator to produce two lists of numbers ("Random.org," n.d.). The first list was of numbers 1-12 (the high physical fitness group) and the second list was 13-

22 (the low physical fitness group). I used these lists to select five shirts from each group plus the control shirt. Every female smelled the control shirt, but they only smelled a small subset of the two groups of men. I took the shirts out of their respective Ziploc baggies and placed them in separate 6"x6" cardboard boxes. I taped the box shut and then labeled it on at least three sides with the number of the shirt. On a side that I did not label and did not have tape, I cut a small triangular hole into the box to allow females to sniff the shirts. I shuffled the 11 boxes and placed one at each station. I kept the shirts that were not in use inside their Ziploc baggie inside their box. At the end of each day, I opened each box and placed the shirt back in the Ziploc baggie to prevent the smells from diffusing overnight. The laptops and other supplies were stored in a locked lab to ensure the security of the items and information.

I scheduled 11 sessions across three days with a cap of 11 females per session. The room was setup with three rows of stations. There were three seats in the back row, four seats in the middle row, and four seats in the front row. I have included a diagram of the setup in Appendix L. I used Trifold boards as dividers to prevent female participants from providing visual cues to one another. I used one trifold to separate each station from a neighboring station. I used four additional trifolds between the middle and front row to prevent participants from seeing cues from participants in front of them. There were not enough trifolds on the first day to put up dividers between the back and middle row. I did not introduce additional dividers after the first day to provide consistency between days.

When the females came into the lab, I told them that they could sit at any of the 11 stations, but they had to pick a seat with a laptop. The laptops had connectivity problems, so I instructed participants to use their own electronic devices that were internet capable. The majority of the students used their cellphones to complete this study. At the start of each session, I emailed the participants two links: the first link was to the demographics and relationship assessment surveys; the second link was to the sweaty t-shirt scale. Participants completed the demographics and relationship assessment scale first. Once all the participants finished the surveys, they started the experiment as a group. I told them that they would have a minute and a half to smell each t-shirt and answer six questions about it. I used my cellphone to measure the time. At the alarm, I told females to stop sniffing and pass their box to the next participant. I facilitated the passing the first few times, until the participants understood the passing pattern. The direction the boxes traveled is included as a diagram in Appendix L. I told the participants they were finished once they completed the 11^{th} shirt. I thanked them for their time and told them that they were free to go.

My goal was to blood type each of the male and female participants when they came into the lab, but I ran out of anti-sera before finishing with my male participants. I contacted the males who were not typed or whose blood type was unclear from the first typing to ask them to come into the lab. I contacted female participants via email and the psychology research pool to have them come in for their blood typing about a week after they completed the first phase of the study. I used the same procedure to collect and assess the female participants. I combined all of the data into two SPSS files. The first was all of the demographic surveys. The second was the t-shirt sniffs data.

RESULTS

Table 3 summarizes the demographics of the participants of this study. I have presented the data with males and female as separate groups and one column with the averages of both groups without weighting. The average male participant in this study was single, Caucasian, 21.86 years of age, a sophomore, protestant, heterosexual, living with his family, not employed, had 1.82 siblings, and did not have pets. The average female participant in this study was single, Caucasian, 19.75 years of age, a freshman, protestant, heterosexual, living with roommates, not employed, had 2.42 siblings, and did have pets.

I used independent-groups t-tests to look for significant demographic differences based on my three key grouping variables: sex, birth control (females only), and fitness level (males only). There are approximately 17 demographic variables. I excluded two participants from all of the analyses because they did not self-identify as male or female. Table 4 is a summation of the significant demographic differences by sex. Of the four variables that were significant (age, year, living arrangement, and pets), year was the only variable that was marginally significant ($p = .061$). Year was included in the table because the Levene's test strongly suggests that if there were not such a strong violation of the assumption of homogeneity ("How do I interpret data in SPSS for an independent samples t-test?," 2008), the p-value for the difference score would be lower than .05. 'Number of people living in your home' was the only variable that was significantly different between women who were and were not on birth control ($p = .030$). Women not on birth control had approximately one more person in their home than women on birth

Table 3

Means and SDs of Demographic Variables by Sex

	Males		Females		All	
	Mean	SD	Mean	SD	Mean	SD
Age	21.86	3.256	19.75	2.219	20.32	2.804
Year	2.50	1.336	1.90	0.952	2.02	1.076
Race[a]	1.00	1.296	1.00	1.034	1.00	1.100
Religion[a]	2.00	1.859	2.00	2.102	2.00	2.023
Employed[a]	0.00	0.671	0.00	0.638	0.00	0.643
Personal Income	2.05	1.914	1.88	1.891	1.94	1.896
Family Income	5.36	1.465	4.81	1.781	4.93	1.706
Personal Education	3.27	0.935	3.22	1.038	3.23	1.000
Mother's Education	4.00	1.690	4.08	1.750	4.04	1.722
Father's Education	4.41	2.153	4.22	2.050	4.28	2.045
Sexual Orientation[a]	1.00	0.767	1.00	0.628	1.00	0.654
Living Arrangement[a]	2.00	0.486	4.00	1.103	4.00	1.114
Siblings	1.82	1.45	2.42	1.572	2.29	1.542
Household Size	2.77	1.343	3.42	1.798	3.30	1.718
Pets[a]	0.00	0.477	1.00	0.496	1.00	0.502

[a] Signifies that the mode was reported instead of the mean.

Table 4

Significant Demographic Differences by Sex

	Males		Females		Levene's	Sig	*t*	Sig
	Mean	SD	Mean	SD	*f*			
Age	21.86	3.256	19.75	2.219	5.976	.016	2.850	.008
Year	2.50	1.336	1.90	0.952	5.095	.026	1.951	.061
Living Arrangement	2.05	0.486	3.28	1.103	27.892	.000	-7.413	.000
Pets	.32	0.477	.58	0.496	3.785	.055	-2.212	.029

control. Age was significantly different between the two levels of physical fitness ($p < .05$)

I ran a one-way ANOVA with each of the five dependent variables (DVs) (strength, physical fitness ($p = .018$), with the low physical fitness males being approximately 3 years older than the high physical fitness males.

In addition to independent-groups t-tests, I ran χ^2 analyses with each of my grouping variables on race and blood type. Both race and blood type are true categorical variables and I suspected that a t-test would not be sufficient to check for over/underrepresentation of a given race or blood type. Race and blood type by sex both violated the assumption that race and blood type were normally distributed by sex. The coefficient for race was χ^2 (5, N=94) = 11.155, $p = .048$. The coefficient for blood type was χ^2 (7, N=75) = 16.880, $p = .018$. Neither race nor blood type were violated when grouped by birth control. Only race was violated when grouped by male fitness level. The coefficient for race was χ^2 (3, N=22) = 11.244, $p = .010$. This means that race was not evenly distributed between the two groups.

I used inferential statistics to answer the four research questions: 1) is there a relationship between blood type and sexiness, 2) is there a relationship between physical fitness and sexiness, 3) is there and interaction between blood type and physical fitness on sexiness, and 4) does hormonal birth control change the nature of the relationship between blood type and sexiness. The five dependent variables for this study were how strong does the shirt smell (strength), how pleasant does the shirt smell (pleasant), how sexy does the shirt smell (sexy), would you be willing to date the man who wore this shirt (would date), and would you be willing to have sex with the man who wore this shirt (would sex).

The first two questions asked about the main effects of blood type similarity and male physical fitness on each of the five dependent variables. The last two questions ask about interactions between 1) blood type similarity and male fitness and 2) blood type similarity and hormonal birth control. I created two distinct codings for blood type similarity. I then ran analyses twice for each set of questions and dependent variables that looked for a relationship with blood type similarity. Both versions of blood type similarity ranged from 0 (no similarity between female's and male's blood type) and 3 (exact match between female's and male's blood type). Appendix N includes a table of how I coded each blood type comparison. Similarity 1 (Sim 1) treated the control shirts as missing for blood type similarity. Similarity 2 (Sim 2) treated the control shirts as 0 degrees of similarity for blood type similarity. The literature did not address the use of control shirts, so I reported both analyses below.

I used two analyses to address the first research question (is there a relationship between blood type and perceived pleasantness/sexiness of a male's scent). First, I created a correlation matrix to check for a relationship, its strength, and direction between blood type and the dependent variables. Table 5 shows the results from this analysis. It is clear from the correlation matrix that the coding of the control shirts makes a significant difference in the results. Blood type as measured by Sim 1 has a strong positive relationship with three of the dependent variables: pleasantness (r (608) = .093, p = .021), willingness to date (r (608) = .081, p = .045), and willingness to engage in sex (r (608) = .085, p = .036). Coding the control shirt as 0 for similarity (Sim 2) washed out the

Table 5

Correlation matrix of blood type similarity variables and dependent variables

		Sim 1	Sim 2	Strong	Pleasant	Sexy
Sim 1	r	1.000				
	p-value	.000				
Sim 2	r	1.000	1.000			
	p-value	.000	.000			
Strong	r	-.046	**.129	1.000		
	p-value	.259	.001	.000		
Pleasant	r	*.093	.036	*-.189	1.000	
	p-value	.021	.352	.000	.000	
Sexy	r	.077	.041	*-.074	**.826	1.000
	p-value	.058	.285	.037	.000	.000
Date	r	*.081	.036	**-.148	**.760	**.818
	p-value	.045	.343	.000	.000	.000
Sex	r	*.085	.046	**-.101	**.717	**.779
	p-value	.036	.229	.005	.000	.000

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Table 5 (con't)

Correlation matrix of blood type similarity variables and dependent variables

		Date	Sex
Date	r	1.000	
	p-value	.000	
Sex	r	**.864	1.000
	p-value	.000	.000

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

significant relationships just listed, but produced a significant relationship with strength of smell (*r* (680) = .129, p = .001).pleasantness, sexiness, willing to date, and willing to sex) with one of the similarity variables as a grouping variable. The first ANOVA used Sim 1. The Levene's test showed no significant violations of homogeneity ("How do I interpret data in SPSS for an independent samples t-test?," 2008). Pleasantness was the only variable that was statistically significant ($F(3,606) = 2.86$ p = .037). Sexiness was trending (p = .073), but still not statistically significant. Fisher's Least Significant Differences (LSD) showed that the significant difference were between one degree of similarity versus two (p = .024) and three (p = .007) degrees of similarity. Female participants rated one degree of similarity as less pleasant in both comparisons. When I regressed Sim 1 on pleasantness it produced a significant model (p = .021).

When I ran the same analyses with Sim 2, the results were not the same. Pleasantness showed a strong trend towards violating the homogeneity assumption (p = .066 vs. p = .936). Strength ($F(3,676) = 10.97$ p < .000), pleasantness ($F(3,676) = 3.77$ p = .011), and sexiness ($F(3,675) = 2.71$ p = .045) were statistically significant. The LSD post hoc analyses showed that 0 degrees of similarity was significantly less strong smelling than all other groups (all p < .001). Pleasantness was significantly lower for one degree of similarity versus 0 (p = .006), 2 (p = .021), and 3 (p = .006) degrees. Sexiness showed the same pattern as pleasantness. One degree of similarity was less sexy than 0 (p = .036), 2 (p = .020), and 3 (p = .023) degrees. The regression of Sim 2 on pleasantness did not produce a significant model (p = .352). The results from both sets of analyses suggest that there is a positive relationship between blood type similarity and pleasantness. The relationship between the other DVs was not as clear.

The second research question asked if there is a relationship between physical fitness of the male and the pleasantness and/or sexiness of his smell. Fitness had three levels: control, low, and high. I used a one-way ANOVA to determine the relationship between the DVs and physical fitness. The assumption of homogeneity of variance was violated for four out of the five DVs: Pleasantness ($p = .001$), sexiness ($p = .003$), willing to date ($p = .006$), and willing to sex ($p = .009$). The omnibus test was statistically significant for all five DVs. The f-value for Strength was $F(2,789) = 33.26$, $p < .001$. The f-value for pleasantness was $F(2, 789) = 9.22$, $p < .001$. The f-value for sexiness was $F(2, 788) = 9.89$, $p < .001$. The f-value for willing to date was $F(2, 789) = 8.58$, $p < .001$. The f-value for willing to have sex was $F(2, 789) = 7.952$, $p < .001$. The post hoc analysis showed that the control shirt smelled less strongly than both groups of males ($p < .001$). The high physical fitness group smelled less pleasant that the control ($p = .002$) and low fitness shirts ($p < .001$). The high physical fitness group smelled less sexy than the control ($p = .015$) and low fitness shirts ($p < .001$). Women were less willing to date the high physical fitness shirt compared to the control ($p = .012$) and low fitness shirts ($p < .001$). Women were less willing to date the high physical fitness shirt compared to the control ($p = .033$) and low fitness shirts ($p < .001$). These results suggest women preferred the low fitness and control shirts to the high fitness shirts.

The third research question asked if there is an interaction between fitness level (control, low, and high) and similarity of blood type (ranging from 0-3) on pleasantness and/or sexiness of a male's scent. I ran two sets of 3x4 ANOVAs for each of the dependent variables. Sim 1 by fitness produced three significant interactions: Strength (F (3, 602) = 3.94, $p = .008$), pleasant (F (3, 602) = 3.38, $p = .018$), and Sexy (F (3, 601) =

2.60, $p < .052$). Would date ($p = .094$) and would sex ($p = .129$) were not significant. Sim 2 by fitness produced the same significant relationships: Strength ($F(3, 671) = 4.04$, $p = .007$), pleasant ($F(3, 671) = 3.53$, $p = .015$), and sexy ($F(3, 670) = 2.71$, $p < .044$). Would date ($p = .084$) and would sex ($p = .121$) were not significant. The follow-up analysis showed that there was a significant difference between one degree of similarity and 0 degrees ($p = .006$), 2 degrees ($p = .019$), and 3 degrees ($p = .006$) for pleasantness and sexiness. Strength of smell produced significant differences between 0 degrees of similarity and all other degrees (all p-values were $p < .001$). The pattern did not change between Sim 1 and Sim 2, so I have only included the figures for Sim 2 for the three significant dependent variables. Figure 1 shows the pattern for strength of smell by blood type and physical fitness. Figure 2 shows the pattern for pleasantness of smell by blood type and physical fitness. Figure 3 shows the pattern for sexiness of smell by blood type and physical fitness.

The fourth research question asked if there was an interaction between birth control (yes or no) and similarity of blood type. I ran two sets of 2x4 ANOVAs for each of the dependent variables. I found no significant interactions between blood type similarity and birth control regardless of the version of blood type similarity that I used. Of the ten ANOVAs that I produced to assess the potential interaction between birth control and blood type similarity, none had a p-value less than .300. These results strongly suggest that there is no interaction between birth control and blood type similarity.

Figure 1

Interaction Between Blood Type Similarity and Physical Fitness on Strength of Smell

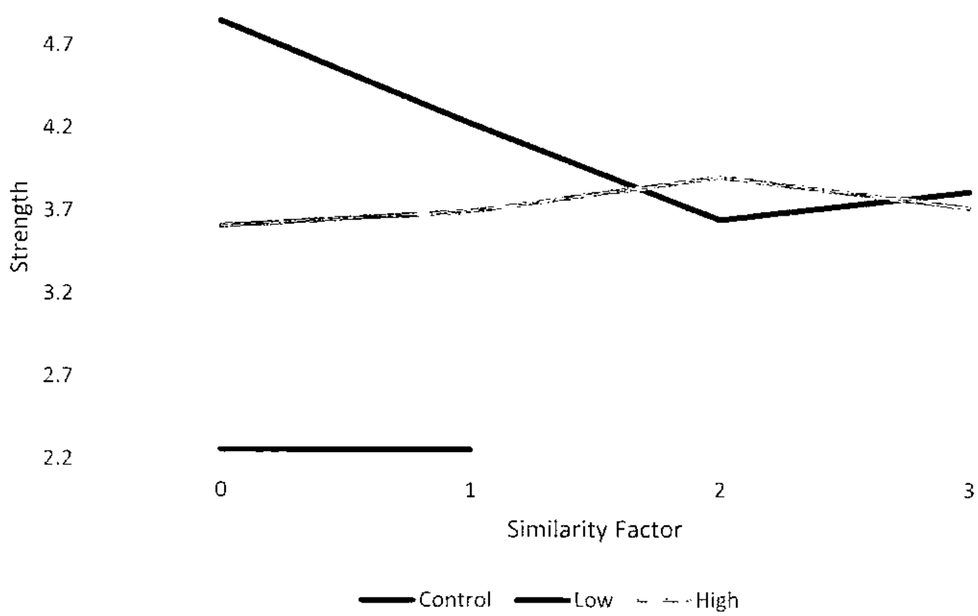


Figure 2

Interaction Between Blood Type Similarity and Physical Fitness on Pleasantness of Smell

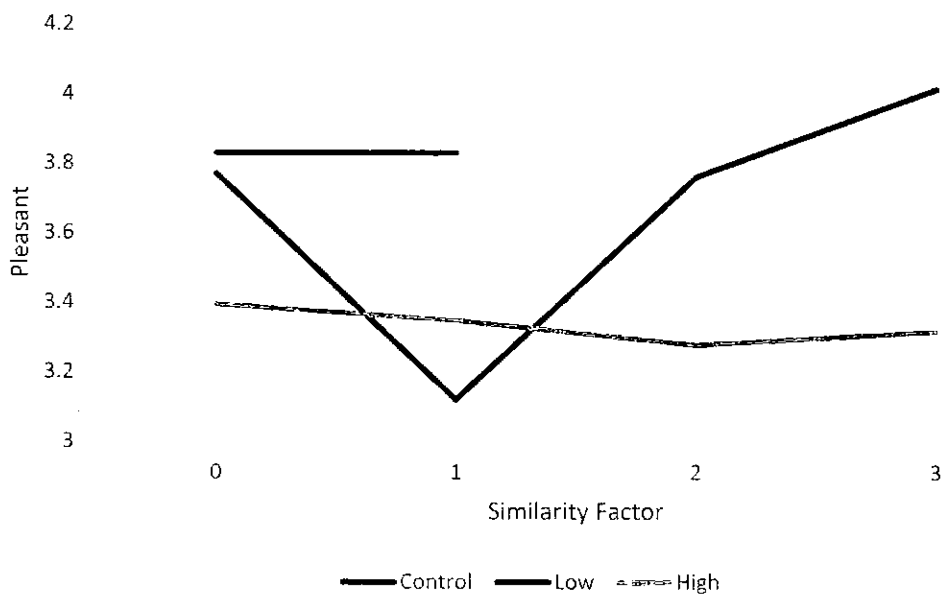
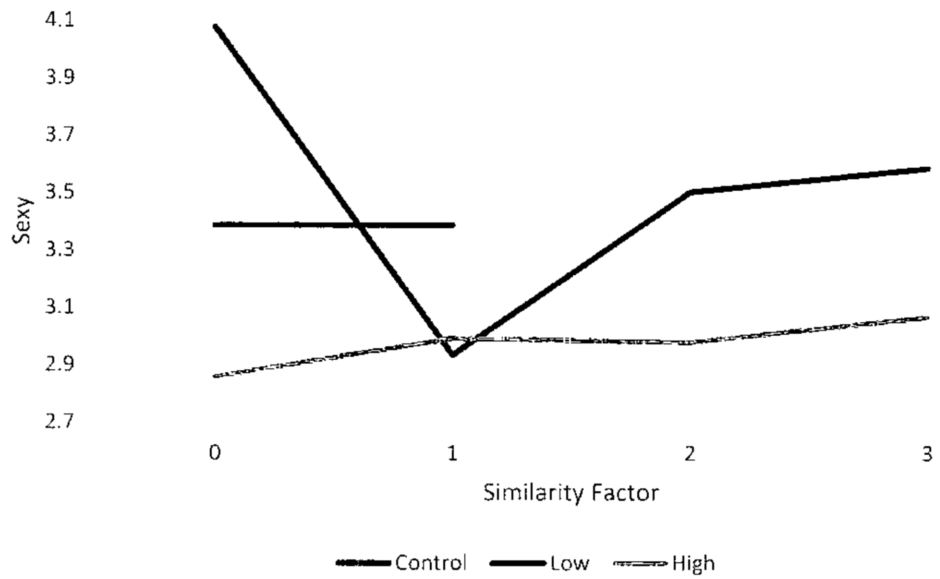


Figure 3

Interaction Between Blood Type Similarity and Physical Fitness on Sexiness of Smell



DISCUSSION

Overall, the results from the analyses do not support the original sweaty t-shirt study (Wedekind et al., 1995) or any of the other studies that showed women selecting men based on a disassortative pattern of mating (Santos et al., 2005; Thornhill et al., 2003; Wedekind & Furi, 1997).

The results from this study suggest that blood type does not produce the same pattern as HLA type when women select mates based on olfactory cues. Santos et al. (2005), Thornhill et al. (2003), Wedekind et al. (1995), and Wedekind and Furi (1997) all produced disassortative patterns of mate preference based on olfactory cues (women preferred men with different genes based on smell). Jacob et al. (2002) and Roberts et al. (2008) are the only authors who did not produce this pattern. Jacobs et al. (2002) found an intermediate (or allele-sharing) preference. Roberts et al. (2008) found no statistical significance.

This could be due to the lack of relationship between blood type and HLA type (Erikogule, Büyükdogan, & Cora, 2011). I used blood type instead of HLA type based on the work of Erikogule, Büyükdogan, & Cora (2011). The research suggested that there might have been a correlation between blood type and HLA antigens. I did not obtain participants' HLA type, so I cannot make any inferences about the relationship between blood type and HLA type. My results did not produce statistically significant differences between blood types.

The first set of ANOVAs produced a main effect for blood type similarity and pleasantness, but not sexiness when I coded the control shirts as missing. When I included the control shirts, sexiness became significant, but only marginally so. For all of the analyses, I treated blood type similarity as a grouping variable rather than a continuous variable. When I treated blood type similarity as categorical, the appropriate analysis was a one-way ANOVA comparing each degree of similarity, ranging from 0-3, as a unique group. In analyses of both versions of blood type similarity, 1 degree of similarity was rated as less desirable than all other groups. There were no other significant differences. This pattern showed up in several other analysis which may be reason to consider looking into the '1 degree of similarity' group to check for potential confounds. The trend between similarity and the dependent variables, except strength, were generally positive. This means that as similarity increased, so did desirability. This is the opposite of what other olfactory cue studies found (Havelicek & Roberts, 2009; Herz & Cahill, 1997; Herz and Inzlicht, 1997; Jacobs et al., 2003; Santos et al., 2005; Thornhill et al, 2003; Wedekind & Furi, 1997; Wedekind & Penn, 2000, Wedekind et al., 1995).

Buss (1989), Rosenblatt (1974), and Symons (1979, 1995) research suggests that only males are sensitive to biological cue of mating and physical fitness. The results of the analyses of the second research question suggest that there are olfactory cues for fitness and that women are sensitive to these cues. The problem with this statement is that fitness just smelled stronger. Strength of smell is consistently negatively correlated with pleasantness and sexiness (Wedekind et al., 1995). The results suggest that had strength of smell been controlled for that there would have been no difference in pleasantness or sexiness between the high and low physical fitness groups (as there was no difference between the low and control).

Women did not select the high physical fitness males as would have been predicted based on Buss (1989), Rosenblatt (1974), and Symons (1979; 1995). This could be due to the difference in activity level between the high and low physical activity level groups. Herz and Cahill (1997) and Herz and Inzlicht (2002) suggest that there is a relationship between olfactory cues and visual cues. I was not able to collect and show photos of the participants to the subjects. This means I cannot make any claims based on my data about the relationships between olfactory and visual cues.

The correlation matrix shows findings similar to the original study (Wedekind et al., 1995) regarding the relationships between the various dependent variables. Sexiness and pleasantness has a strong positive relationship in both studies (Wedekind's correlation coefficient was $r = .83$ and $p < .001$ (Wedekind et al., 1995), while my coefficient was $r = .826$ and $p < .001$). Strength of smell is negatively correlated with pleasantness, sexiness, willingness to date, and willingness to have sex. Other than strength, all of the other dependent variables have strong positive correlations. The reason this is important is that Wedekind (Wedekind et al., 1995) and other researchers (Santos et al., 2005; Thornhill et al., 2003; Wedekind & Furi, 1997) typically use these relationships as grounds for only reporting a single dependent variable of their choice, typically pleasantness. As I ran my analyses and looked at the various relationships each dependent variable produced, pleasantness was fairly consistent at producing a significant effect. The same was not true for sexiness, despite the strong positive correlation ($r = .826$, $p < .001$). I cannot say whether or not this was the case for the other studies, but if it were, only reporting pleasantness would be seriously misleading.

The interaction between blood type and physical fitness produced a significant interaction for strength, pleasantness, and sexiness for both versions of similarity. The only consistent pattern that came out of these analyses was that one degree of similarity smell significantly less desirable than all other groups for each of these three dependent variables. I think this was significant only because of outliers in one of the blood type groups. This suggests the results addressing the third research question are likely due to the confound of strength of smell mentioned in the previous paragraphs. If one fitness group was overrepresented in a certain blood type that would create a difference that could only be fixed by increasing sample size. I received minimal financial support, so increase the male groups was not possible.

The results from the final research question were contrary to Wedekind's et al. (1995) results. He found that hormonal birth control changed the selection and preference patterns. My results showed that there was no difference between women who were on birth control and those who were not regardless of the similarity variable that I used. One possible explanation of the difference is that the groups of women were not even. I had more women who were not on birth control than I expected, but statistical weighting would have been needed to correct for this difference. Another option would be to recruit or offer additional incentives for women not on hormonal birth control.

The demographic results suggest that I did not have a random sample (among other problems with the participant selection process). In effect, the high physical fitness group was a group of African American males that I compared to the low physical fitness group, a group of Caucasian males. The cause of this incongruence is due in part from the fact that I selected the high fitness group of males from a subpopulation of the university that has a very different racial composition than the rest of the university. To state this another way, the university where I conducted the study has almost no African-American students (barely 5% based on a university report (Student Population Fast Facts, 2014)) who are not athletes, regardless of their sex. The issue of race is made slightly less salient as blood type frequencies are similar across these two groups ("Blood type charts," n.d.). Had HLA type been used, this could have been a much more serious confound as there tend to be significant differences in the CWDs between racial groups.

The other demographic differences that I mentioned are also likely due to sampling restrictions and demand characteristics. Rather than having access to the entire university, I only had access to a subset of males and females who were currently enrolled in lower division psychology courses. This was a sample of convenience, not a random sample. The concept of demand characteristics is relevant here because it is typically considered bad to not exercise (on a regular basis). During the initial recruiting phase, I went into various classes to recruit males for the study. It was clear that many of the male students took pride in announcing that they were not eligible for the study as they worked out on a regular basis. I think that most, if not all of the demographic differences are artifacts of the pool composition, size, and lack of truly random selection.

All of these results considered together suggest that there are significant effects of blood type similarity and physical fitness, but they may not be large effects. These results also suggest that there are probably one or more mediating variables I did not measure or control. Evolutionary theory suggests that it would be wise to follow-up these analyses with additional measures of characteristics females find desirable in potential mates, such as height, weight and age. Another potential mediating variable was strength of smell. I looked at strength of smell and its relationship with fitness and found a significant difference between the low and high physical fitness groups. The high physical fitness groups smelled stronger. It is likely that this is due in part to the fact that the high physical fitness men wore their shirts during the daily workouts and practice. I instructed the other group of males not to change their routines and not to exercise during the time they had on their shirts. Some of the shirts from the high fitness group came back with enough sweat on them that I could have easily wrung them. If the levels of smell had been held constant, would there still have been a difference in desirability?

The dataset from this study is large and offers a variety of additional analyses that are beyond the scope of the original four research questions. Order effects, how much time had passed since the shirt had been worn by the male subjects, and a variety of other grouping variables will hopefully offer additional insight into the mystery of why women found certain smells sexier than others.

Limitations

Male participants presented several problems throughout their stages of participation in this study. Many of the male athletes reported that they do not check their email. As email was the primary means of communication, this caused an increase in the amount of time it took to recruit the first group of males. Of the initial group of 15 males (as well as some of the replacement males) several committed to participate in the study initially and then backed out later. The rate of attrition made matching males very challenging.

While I planned to do extensive matching between the two groups of male participants, it was clear that I would not be able to do any meaningful matching when the first wave of non-athletes signed up for the study. There were no complete matches on age, race, height, and weight. At best, I could have matched males for age. The other serious issue with the low physical fitness group of males was that there were very few males who worked out once a month or less to select from. The original definition of low physical fitness was less than once a week, but working out a few times a month plus a physically strenuous job did not create the desired dichotomy. Participants from this group raised three other important points.

First, there was no question about mode of transportation in the matching scale. One male reported that he never exercised, but that he biked to all of his classes. Second, participants raised the question about what shampoo should they use. This was not mentioned in the original sweaty t-shirt study. Due to costs, I instructed males to use their own shampoo. One male reported that after he used his shampoo he washed his hair again with the unscented soap that I provided. While I greatly appreciated the extra effort that male put into monitoring his behavior, it seems highly improbable that the other males followed his example. The other issue that male participants made clear was that asking what size t-shirt they wore provided inconsistent fitting across participants. One male who was about 150 lbs. requested an extra-large t-shirt. The shirt would have had almost no physical contact with him while he wore it.

The solution to each of these issues is straightforward. Rather than only ask about specific activities, asking males about what activities they do over the course of a day and/or week would give a more holistic view of each potential participants' activity level. The solution to the second problem is to seek additional funding. The last problem has two potential solutions: the participants could come in for a prescreening, or, for a more time efficient solution, ask males to measure their chest size. The former allows males to actually try on different sizes; the latter is more likely to get compliance, especially from males who are not receiving course credit for their participation.

The other limitation of this study involving the male participants was their ability to show up on time to the pick-up and drop off materials. The meetings were set up to be at discreet times to minimize the wait time of male participants. After the first fifteen minutes passed males from other time slots began just dropping in and disrupting the flow of the first group of males. There were about three no shows to the first meeting, which reduced the number of shirts available to be sniffed. Of the males who did show up to the first meeting, two missed the original deadline to drop off their shirts. Both males were from my smaller group (low physical fitness) that would have had less than 10 participants, so I took their shirts when they came in later on the same day the shirts were due. One male came in after the shirts had been turned in and asked if he could still be part of the study. I had to explain to him several times that the male part of the study was finished. He then tried to sign up for one of the sessions for the female participants. I had him removed from the session so that a female participant could take his spot.

The limitations of this study involving the female participants were not as extensive. The problems that I encountered were not having a sufficient number of blinders, talking/sitting next to friends, English as a second language, and perfumes.

I changed the space where I conducted the research about a week prior to running the study. There were enough blinders to separate neighbors and the front row from the middle row. Participants in the back row could not see what their neighbors were doing as they sniffed the shirts, but they could see what the participants in front of them were doing as they sniffed their shirts. I did not add additional blinders after the first day to maintain consistency between each of the sessions.

There were multiple groups of female participants who signed up to participate in the study at the same time as their friends. These groups tended to be talkative and more animated than females who came in alone. The same was true of one pair of participants who were exchange students. It was clear they spoke conversational English, but they struggled with some of the vocabulary used in the surveys. One example of this was trying to explain 'date of your last period.' When I said menstruation, they were still unsure of the meaning of the question. When I said 'your lady week' one of them understood the meaning of the question and translated it for her friend. The last problem could have easily been avoided with a bit more forethought on my part. There were a few sessions where female participants came in wearing perfume, lotion, and/or hairspray with a very strong scent. During one of the sessions, the smell was so strong that before we started I asked the participants if they had just put on perfume to please go to the bathroom to wash it off.

While I encountered other issues during this study, such as men trying to enter the room while it was in use, most of them were not methodological issues. Funding was the only other factor that had an influence on the methodology. I was forced to remove many of the controls, products, and testing materials from the study because of lack of funding. Lastly, the laptops would not connect to the internet. This meant most of the participants completed the surveys on their cellphones. There was no efficient way to capture the type of device the participants used given that new questions would need to be submitted to the IRB. It is unlikely that there would be any difference in the responses.

Finally, I do not have access to any data on the reliability or validity of the scales I used in this study. This is a minor limitation of this study and more a critique of this area of research (there are no scales with these statistics available for use in research). Psychometric analyses are typically conducted in dissertations (not theses), when developing a new instrument intended for use beyond the current project, or when a survey has been used frequently in replications. The scales I designed for this study are not intended for use beyond this research. The scale I used to measure the dependent variables is the only scale which might meet any of these qualifications. The sexy scent scale is an expanded version of the scale used by Wedekind et al. (1995) to measure sexiness and pleasantness of smell. This scale has been used in at least six other studies. Six studies hardly warrants a meta-analysis or psychometric study of a tool, especially considering the tool has been manipulated between studies. Havlicek and Roberts (2009) show, in addition to the six true replications, there are a variety of other studies using HLA to assess mating preferences. If I had measured HLA, then it would be a major limitation to not report the methodology and assessment of that methodology as it has been replicated numerous (more than six) times. Their analyses also show the newness and currently fragmented nature of mate selection studies.

Psychometric analyses of scales are not an afterthought or a measure of the data like a t-test. There are various techniques and steps which must be taken to accurately assess the reliability and validity of an instrument. This is why researchers occasionally form panels of experts to build and revise instruments. None the skills and tools needed to run psychometric testing of scales are taught or offered at this university. I have made no claims about the reliability or validity of the scales I built for this study. Psychometric analyses of reliability and validity of instruments is a study in and of itself and is thus, far beyond the scope of this study as it is not designed or intended to answer questions about the reliability or validity of the scales. For a review of the basic principles of reliability and validity, see Cureton (1965).

Implications

The results from this study do not have applied implications. The results are too inconsistent to be able to make statements about how this research can be used in an applied setting. The only finding that was consistent enough to make a statement about was strength of smell. For men who exercise or are athletically inclined, it is important to show and maintain a certain level of hygiene. This statement still applies to all males, as strength of smell was negatively associated with desirability of smell, but smell is slightly less salient if you are not actively sweating on a regular basis.

The results do have methodological implications. When other researchers replicate and modify the sweaty t-shirt study they need to be very cognizant of how long the males are wearing the shirt, what they are doing when they wear the shirt, and the environments they will be wearing the shirt in. The results presented in this study are a snapshot of everything that was collected to answer the four research questions. In additional analyses, I will be able to add to the existing body of knowledge by assessing the effect of time between when the male removes his shirt and the female sniffs it on strength of smell. I can assess fatigue across sniffs. I can also look to see if the order of the shirt makes a difference. These sound like trivial distinctions, but each piece of data that is added to the general body of knowledge helps us fine tune of skills and tools. We can get a better, more precise image of how much of mate selection is explained through HLA type, blood type, and physical fitness through olfactory cues.

As attitudes towards exploratory analyses (sometimes referred to as HARKing (Kerr, 1998)) are changing, power analyses prior to running a study will become increasingly important in the context of publication and credibility. The effect size I assessed is clearly small. The effect size also suggests that the amount of the behavior we are assessing (mate value assessment and mate acquisition) is limited. Smell makes a significant difference in how much I value a mate and whether or not I want to mate with him, but that difference is small enough that a potential mate could easily compensate for a less than satisfactory scent if he cared enough to gain sexual access.

References

Adams, E. J. (2001). *The evolutionary genetics of Major Histocompatibility Complex (MHC) Class I genes in great apes* (Unpublished doctoral dissertation). University of California, Berkley, Berkeley, CA.

Alexander, R. D. (1979) *Darwinism and human affairs*. Seattle: University of Washington Press.

Archie, E. A., Henry, T., Maldonado, J. E., Moss, C. J., Poole, J. H., Pearson, V. R., Murrary, S., Alberts, S. C., & Fleischer, R. C. (February, 2010). Major histocompatibility complex variation and evolution at a single, expressed DQA locus in two genera of elephants. *Immunogenetics*, *62*(2), 85-100.

Ardry, R. (1966). *The territorial imperative*. New York: Atheneum.

Axelrod, R. (1984). *The evolution of cooperation*. New York: Basic Books.

Axelrod, R. & Hamilton, W. D. (1981). The evolution of cooperation. *Science, 211*, 1390-1396.

Billings, J. & Sherman, P. W. (1998). Antimicrobial functions of spices: Why some like it hot. *Quarterly review of Biology, 73*, 3-49

Blood type charts. (n.d.). Retrieved March 1, 2015, from American Red Cross website: http://www.redcrossblood.org/learn-about-blood/blood-types

Brandes, J. (1967). First trimester nausea and vomiting as related to outcome of pregnancy. *Obstetrics and Gynecology, 30*, 427-431.

Burnstein, E., Crandall, C., & Kitayama, S. (1994). Some neo-Darwinian decision rules for altruism: Weighing cues for inclusive fitness as a function or the biological importance of the decision. *Journal of Personality and Social Psychology, 67*, 773-789.

Buss, D. (1989). Sex differences in human mate preferences: Evolutionary hypotheses tested in 37 cultures. *Behavioral & Brain Sciences, 12*, 1-49.

Buss, D. (2003). *The evolution of desire: Strategies of human mating (Revised Edition).* New York: Free Press.

Buss, D. (2012). *Evolutionary psychology: The new science of the mind* (4th ed.). Pearson.

Cosmides, L. & Tooby, L. (1992). Cognitive adaptations for social exchange. In J. Barkow, L. Cosmides, & J. Tooby (Eds.), *The adapted mind* (pp. 163-228). New York: Oxford University Press.

Cureton, E. E. (1965). Reliability and validity: Basic assumptions and experimental designs. *Educational and Psychological Measurement. 25.2*, 327-346.

Daly, M., & Wilson, M. (1988). *Homicide.* Hawthorne, NY: Aldine.

Daly, M., & Wilson, M. (1994). Evolutionary psychology of male violence. In J. Archer (Ed.), *Male Violence* (pp. 253-288). London: Routledge.

Daly, M., & Wilson, M. (1996). Violence against stepchildren. *Current Directions in Psychological Science, 5*, 77-81.

Daly, M., Wilson, M., & Weghorst, S. J. (1982). Male sexual jealousy. *Ethology and Sociobiology, 3*, 11-27.

Eastwick, P. W., Neff, L. A., Finkel, E. J., Luchies, L. B., & Hunt, L. L. (2014). Is a Meta-analysis a Foundation, or Just Another Brick? Comment on Meltzer, McNulty, Jackson, and Karney. *Journal of Personality and Social Psychology, 106*, 429-434.

Erikogule, M., Büyükdogan, M., & Cora, T. (2011). The relationship between HLA antigens and blood groups. *European Journal of General Medicine, 8*(1), 65-68.

Fessler, D. M. T. (2002). Reproductive immunosuppression and diet. *Current Anthropology, 43*, 19-38.

Flinn, M. (1988). Parent-offspring interactions in a Caribbean village: Daughter guarding. In L. Betzig, M. Borgerhoff Mulder, & P. Turke (Eds.), *Human reproductive behavior: A Darwinian perspective* (pp. 189-200). Cambridge, UK: Cambridge University Press.

Gilbert, A. N., Yamazaki, K., Beauchamp, G. K., & Thomas, L. (1986). Olfactory discrimination of mouse strains (Mus musculus) and major histocompatibility types in humans (Homo sapiens). *Journal of Comparative Psychology, 100(3)*, 262-265.

Greiling, H. (1995, July). Women's mate prefences across contexts. Paper presented to the Annual Bibliography Meeting of the Human Behavior and Evolution Society, University of California, Santa Barbara.

Greiling, H. & Buss, D. M. (2000). Women's sexual strategies: The hidden dimension of short-term extra-pair mating. *Personality and Individual Differences, 28*, 929-963.

Haselton, M., Buss, D. M., Oubaid, V., & Angleitner, A. (2005). Sex, lies, and strategic interferences: The psychology of deception between the sexes. *Personality and Social Psychology Bulletin, 31*, 3-23.

Havlicek, J. & Roberts, S. C. (2009). MHC-Correlated mate choice in humans: A review. *Psychoneuroendocrinology, 34*, 497-512.

Hedrick, P. W. (June, 1994). Evolutionary genetics of the major histocompatibility complex. *The American Naturalist, 143(6)*, 945-964.

Herz, R. S., & Cahill, E. D. (1997). Differential use of sensory information in sexual behavior as a function of sex. *Human Nature, 8*, 275–286.

Herz, R. S. & Inzlicht, M. (2002), Sex differences in response to physical and social factors involved in human mate selection: The importance of smell for women. *Evolution and Human Behavior, 23*, 359-364.

[How do I interpret data in SPSS for an independent samples t-test?]. (2008). Retrieved May 5, 2015, from http://statistics-help-for-students.com/ How_do_I_interpret_data_in_SPSS_for_an_independent_samples_T_test.htm#.VUlXrPm-1sI

Hrdy, S. (1981). *The Woman that Never Evolved.* Cambridge: Harvard University Press.

Hughes, A. L. & Nei, M. (1989). Evolution of the Major Histocompatibility Complex: Independent origins of nonclassical Class I genes in different groups of mammals. *Molecular biology and evolution, 6(6)*, 559-579.

Jacob, T. J. C., Fraser, C., Wang, L. W., Walker, V., O'Connor, S. (2003). Psychophysical evaluation of responses to pleasant and mal-odour stimulation in human subjects; adaptation, dose response and gender differences. *International Journal of Psychophysiology, 48*, 67-80.

Kerr, N. L. (1998). HARKing: Hypothesizing after the results are known. *Personality and Social Psychology Review, 2*, 196-217.

Mack, S. J., Cano, P., Hollenbach, J.A., He J., Hurley, C. K., Middleton, D., Moraes, M. E., Pereira, S. E., Kempenich, J. H., Reed E. F., Setterholm, M., Smith, A. G., Tilanus, M. G., Torres, M., Varney, M. D., Voorter, C. E., Fischer, G. F., Fleischhauer, K., Goodridge, D., Klitz, W., Little, A. M., Maiers, M., Marsh, S. G., Müller, C. R., Noreen, H., Rozemuller, E. H., Sanchez-Mazas, A., Senitzer, D., Trachtenberg, E., & Fernandez-Vina, M. (2013). Common and well-documented HLA alleles: 2012 update to the CWD catalogue. *Tissue Antigens, 81(4)*, 194–203.

Maslow, A. H. (1943). A theory of human motivation. *Psychological Review, 50(4)*, 370-396.

Meltzer, A. L., McNulty, J. K., Jackson, G., & Karney, B. R. (January, 2013). *Sex differences in the implications of partner physical attractiveness for the trajectory of marital satisfaction*. Paper presented at the Close Relationships Pre-Conference of the annual meeting of the Society for Personality and Social Psychology, New Orleans, LA.

Parham, P. (2009). *The Immune System* (3rd ed.). Garland Science.

Potts, W. K. & Wakeland, E. K. (December, 1993). Evolution of MHC genetic diversity: A tale of incest, pestilence and sexual preference. *Perspectives, 9(12)*, 408-412.

Profet, M. (1992). Pregnancy sickness as adaptation: A deterrent to maternal ingestion of teratogens. In J. Barkow, L. Cosmides, & J. Tooby (Eds.), *The adapted mind* (pp. 327-366). New York: Oxford University Press.

Random.org. (n.d.). Retrieved February 26, 2015, from https://www.random.org/

Roberts, S. C., Gosling, L. M., Carter, V., Petrie, M. (2008). MHC correlated odour preferences in humans and the use of oral contraceptives. *Proceedings of the Royal Society of London B: Biology, 275*, 2715-2722.

Rosenblatt, P. C. (1974). Cross-cultural perspective on attraction. In T. L. Huston (Ed.), *Foundations of Interpersonal Attraction* (pp. 79-95). New York: Academic Press.

Rozin, P. (1996). Towards a psychology of food and eating: From motivation to module to model to marker, morality, meaning and metaphor. Current Directions in Psychological Science, 5, 18-24.

Rozin, P. & Schull, J. (1988). The adaptive-evolutionary point of view in experimental psychology. In R. C. Atkinson, R. J. Herrnstein, G. Lindzey, & R. D. Luce (Eds.), Stevens' handbook of experimental psychology: Vol 1. Perception and motivation (2^{nd} ed., pp. 503-546). New York: Wiley.

Q&A on living donations. (n.d.). Retrieved January 1, 2015, from National Kidney Fondation website: https://www.kidney.org/transplantation/livingdonors/infoQA

Santos, P. S. C., Schinemann, J. A., Gabardo, J., Bicalho, M. D. (2005). New evidence that the MHC influences odor perception in humans: a study with 58 Southern Brazilian students. *Hormones and Behavior, 47*, 384-388.

Sherman, P.W. (1985). Alarm calls of Belding's ground squirrels to aerial predators: Nepotism or self-preservation? *Behavioral Ecology and Sociobiology, 17*, 313-323.

Sherman, P. W. & Flaxman, S. M. (2001). Protecting ourselves from food. *American Scientist, 89*, 142-151.

Smith, R. L. (1984). Human sperm competition. In R. L. Smith (Ed.), *Sperm Competition and the Evolution of Animal Mating Systems* (pp. 601–660). London: Academic Press.

Smuts, B. B. (2009. First printing 1985). *Sex and Friendship in Baboons*. New York: Aldine Publishing Co.

Student population fast facts! (2014). Unpublished manuscript, Emporia State University.

Symons, D. (1979). *The Evolution of Human Sexuality*. New York: Oxford University Press.

Symons, D. (1995). Beauty is in the adaptations of the beholder: The evolutionary psychology of human female sexual attractiveness. In P. R. Abramson and S. D. Pinkerton (eds.), *Sexual Nature/Sexual Culture* (pp. 80–120). The University of Chicago Press.

Table of HLA alleles in each prevalence category [Table]. (2015, February 11). Retrieved from Wikipedia: en.m.wikipedia.org/wiki/Human_leukocyte_antigen

Thornhill, R., Gangestad, S. W., Miller, R., Scheyd, G., McCollough, J. K., Franklin, M. (2003). Major histocompatibility complex genes, symmetry, and body scent attractiveness in men and women. *Behavioral Ecology, 14*, 668-678.

Tieson, F. D., Olsen, C. L., & Hook, E. B. (1985). Influence of cravings and aversions on diet in pregnancy. *Ecology of Food and Nutrition, 17*, 117-129.

Tooby, J. & DeVore, I. (1987). The reconstruction of hominid behavioral evolution through strategic modeling. In W. G. Kinzey (Ed.), *The evolution of human behavior* (pp. 183-237). New York: State University of New York Press.

Trivers, R. L. (1971). The evolution of reciprocal altruism. *Quarterly Review of Biology, 46*, 35-37.

Trivers, R. (1972). Parental investment and sexual selection. In B Campbell (Ed.), *Sexual selection and the descent of man*, 1871-1971 (pp. 136-179). Chicago, IL: Aldine.

Wedekind, C., & Füri, S. (1997). Body odour preferences in men and women: do they aim for specific MHC combinations or simply heterozygosity? *Proceedings of the Royal Society of London B: Biology, 264*, 1471-1479.

Wedekind, C. & Penn, D. (2000). MHC genes, body odours, and odour preferences. *Nephrology Dialysis Transplantation, 15*, 1269-1271.

Wedekind, C., Seebeck, T., Bettens, F., & Paepke, A. J. (June 22, 1995). MHC-Dependent mate preferences in humans. *Biological Sciences, 260*(1359), 245-249.

Williams, C. G. (1966). *Adaptation and natural selection.* Princeton, NJ: Princeton University Press.

Wilson, M., & Daly, M. (1985). Competitiveness, risktaking, and violence: The young male syndrome. *Ethology and Sociobiology, 6*, 59-73.

Wilson, M., & Daly, M. (1993). An evolutionary psychological perspective on male sexual proprietariness and violence against wives. *Violence and Victims, 8*, 271-294.

Wilson, M., & Daly, M. (1996). Male sexual proprietariness and violence against wives. *Current Directions in Psychological Sciences, 5*, 2-7.

Wilson, M., Johnson, H., & Daly, M. (1995). Lethal and non-lethal violence against wives. *Canadian Journal of Criminology, 37*, 331-361.

Wrangham, R. & Peterson, D. (1996) *Demonic males*. Boston: Houghton Mifflin.

Yamazaki, K., Boyse, E.A., Mike, V., Thaler, H.T., Mathieson, B.J., Abbott, J., Boyse, J., Zayas, Z.A., & Thomas, L. (1976). Control of mating preferences in mice by genes in the major histocompatibility complex. *The Journal of Experimental Medicine*, *144*(5), 1324—1335.

Yamazaki, K., Yamaguchi, M., Baranoski, L., Bard, J., Boyse, E.A., & Thomas, L. (1979). Recognition among mice: Evidence from the use of a Y-maze differentially scented by congenic mice of different major histocompatibility types. *The Journal of Experimental Medicine*, *150*(4), 755—760.

FOOTNOTES

[1] Special nomenclature are defined in appendix Q.

Appendix A

IRB Approval

IRB Approval Letter

EMPORIA STATE
UNIVERSITY
GRADUATE SCHOOL AND
DISTANCE EDUCATION

Research and Grants Center
Campus Box 4003
1 Kellogg Circle
Emporia, Kansas 66801-5415
620-341-5351
620-341-5909 fax
www.emporia.edu/research

October 30, 2014

Lydia Njoroge
1754 Road 190
Emporia, KS 66801

Dear Ms. Njoroge:

Your application for approval to use human subjects has been reviewed. I am pleased to inform you that your application was approved and you may begin your research as outlined in your application materials. Please reference the protocol number below when corresponding about this research study.

Title:	Replication of Sweaty T-Shirt Study
Protocol ID Number:	15050
Type of Review:	Expedited
Time Period:	09/01/2014 - 08/31/2015

If it is necessary to conduct research with subjects past this expiration date, it will be necessary to submit a request for a time extension. If the time period is longer than one year, you must submit an annual update. If there are any modifications to the original approved protocol, such as changes in survey instruments, changes in procedures, or changes to possible risks to subjects, you must submit a request for approval for modifications. The above requests should be submitted on the form Request for Time Extension, Annual Update, or Modification to Research Protocol. This form is available at www.emporia.edu/research/irb.html.

Requests for extensions should be submitted at least 30 days before the expiration date. Annual updates should be submitted within 30 days after each 12-month period. Modifications should be submitted as soon as it becomes evident that changes have occurred or will need to be made.

On behalf of the Institutional Review Board, I wish you success with your research project. If I can help you in any way, do not hesitate to contact me.

Sincerely,

Dr. Michael Butler
Institutional Review Board

pf

cc: Dr. Pam MacDonald

Appendix B

Consent Forms

Consent Forms

Female Consent Form

Participant ID = ______ Njoroge (1)

INFORMED CONSENT DOCUMENT

The Department of **Psychology** at Emporia State University supports the practice of protection for human subjects participating in research and related activities. The following information is provided so that you can decide whether you wish to participate in the present study. **You should be aware that even if you agree to participate, you are free to withdraw at any time, and that if you do withdraw from the study, you will not be subjected to reprimand or any other form of reproach.** Likewise, if you choose not to participate, you will not be subjected to reprimand or any other form of reproach.

Study Purpose: This study is designed to see if females at Emporia State University follow similar mate selection patterns as females from other areas. I am asking female participants to smell the shirts of male participants that were worn for the last two days and rate how attractive the smell is. You will answer a few additional surveys, have a small amount of blood drawn, and have a cheek swab collected. Your participation is expected to take just over an hour.

Risk or Discomfort: A small sample of blood will be collected to identify participants' blood type. A cheek swab will be collected to determine participants' Human Leukocyte antigen (HLA) type. The 'HLA' is a group of loci on chromosome 6 that describe the makeup of your immune system. There are no additional forms of risk or discomfort associated with this study.

Benefit: Participation in this study may fulfill course recruitments for students.

Confidentiality: All data will be kept confidential and secure. Any forms that have names (like the consent form) will not be stored with data. Identification numbers will be used to connect forms and mark bio data. All data will be stored in locked rooms.

Medical Treatment: If during any part of this study, a participant is injured due to participation in this they will be escorted (or asked to report) to the university health center for immediate medical care.

If you have any questions, comments, or concerns at any point during or following participation in this study, please contact me, **Lydia Njoroge**, at **lnjoroge@g.emporia.edu**.

"I have read the above statement and have been fully advised of the procedures to be used in this project. I have been given sufficient opportunity to ask any questions I had concerning the procedures and possible risks involved. I understand the potential risks involved and I assume them voluntarily. I likewise understand that I can withdraw from the study at any time without being subjected to reproach."

______________________ ______________________

Subject Date

______________________ ______________________

Parent or Guardian (if subject is a minor) Date

Male Consent Form

Participant ID = ______ Njoroge (1)

INFORMED CONSENT DOCUMENT

The Department of **Psychology** at Emporia State University supports the practice of protection for human subjects participating in research and related activities. The following information is provided so that you can decide whether you wish to participate in the present study. **You should be aware that even if you agree to participate, you are free to withdraw at any time, and that if you do withdraw from the study, you will not be subjected to reprimand or any other form of reproach.** Likewise, if you choose not to participate, you will not be subjected to reprimand or any other form of reproach.

Study Purpose: This study is designed to see if **females at Emporia State University follow similar mate selection patterns as females from other areas. I am asking males to wear a t-shirt for two days while doing their normal daily routine. Those shirts will then be smelled by female participants. I am also checking to see if females can smell physical fitness by having two groups of men wear these t-shirts. One group of males will be university athletes, the other group will be non-athlete who do not exercise. A list of restricted food, beverages, and behaviors will be provided before beginning this study. Participation will involve up to 2 hours where you will have to be on campus. One session at the start of the study where you will pick up your shirt and other materials. The second session will be you returning your shirt and collecting a cheek swab sample. The time between these sessions will be approximately 48 hours.**

Risk or Discomfort: **A small sample of blood will be collected to identify participants' blood type. A cheek swab will be collected to determine participants' Human Leukocyte antigen (HLA) type. The 'HLA' is a group of loci on chromosome 6 that describe the makeup of your immune system. There are no additional forms of risk or discomfort associated with this study.**

Benefit: **Participants in this project will be given a certificate for a meal at a local restaurant. Participation in this study may also fulfill course recruitments for student.**

Confidentiality: **All data will be kept confidential and secure. Any forms that have names (like the consent form) will not be stored with data. Identification numbers will be used to connect forms and mark bio data. All data will be stored in locked rooms.**

Medical Treatment: If during any part of this study, a participant is injured due to participation in this they will be escorted (or asked to report) to the university health center for immediate medical care.

If you have any questions, comments, or concerns at any point during or following participation in this study, please contact me, **Lydia Njoroge**, at **lnjoroge@g.emporia.edu**.

"I have read the above statement and have been fully advised of the procedures to be used in this project. I have been given sufficient opportunity to ask any questions I had concerning the procedures and possible risks involved. I understand the potential risks involved and I assume them voluntarily. I likewise understand that I can withdraw from the study at any time without being subjected to reproach."

______________________________ ______________________

Subject Date

______________________________ ______________________

Parent or Guardian (if subject is a minor) Date

Appendix C

Recruitment Statements

Recruitment Statements

Football Players (To be read to players at a meeting)

Hello, my name is Lydia Njoroge. I am a graduate student in the experimental psychology program. I am here today to recruit about 15 of you to participate in my thesis project. I am looking for highly active, super buff males who are willing to give up sex and alcohol for approximately 48 hours.

I will provide you with a t-shirt to be worn for two days. During this time there will be a few restrictions that I can go into detail about. The main ones are you must sleep alone during this time, no spicy foods, no alcohol, and, as already mentioned, no sex. Once you return these shirts, I will have females smell these shirts to tell me which ones they think are the sexiest.

I will also be collecting your player stats to see if the sexiness of your smell is correlated your skills as a football player. Also, I would like to ask to have men volunteer from different positions so that I can get a variety of body types.

If you decide to participate, I will have you complete a five question survey so I can match y'all to my low physical fitness group. There will be a quick blood sample to determine your blood type and collect a cheek swab when you come in to start the study.

Lastly, I will be providing all of the male participants with a certificate for a free buffet at Gambino's.

Non-athlete Males (To be posted on Canvas)

Low Physical Activity Males

Participation in this study will fulfill all research requirements for PY100/PY211.

Wanted: Males for a two day study. Looking for 15 participants who do **NOT** exercise more than once a week. Males should have body types similar to those listed below:

White Males:

[Example 1] 5'10, 200 lbs.
[Example 2] 6'0, 300 lbs.

African American Males:

[Example 3] 5'9, 175
[Example 4] 6'1, 250

If you match any of these types please contact me for further details.
Participation in this study will fulfill all research requirements for PY100/PY 211.
This may fulfill requirements for other courses at the discretion of the instructor.

Contact Information: Lydia Njoroge, Lnjoroge@g.emporia.edu
Female Participants

Sweaty T-shirt Study

Come smell t-shirts for 2 research points! This study is a replication of the classic sweaty t-shirt experiment. Men wore t-shirts for two days and we'd like to find out which ones have the sexiest stink. Your participation will involve coming to the Science hall building, filling out a few questionnaires, smelling shirts, having a small blood sample drawn, and a cheek swab collected. This study should take around an hour of your time and will earn you 2 research points.

You must be **able to smell**, be **premenopausal**, and **not have had a hysterectomy** to participate in this study.

If you have any questions, comments, or concerns please feel free to contact me, **Lydia Njoroge, at lnjoroge@g.emporia.edu.**

Appendix D

Matching Scale

Matching Scale

Age: ________

DOB: ___/____/_____

Height: ____ FEET ____ INCHES

Weight: ________lbs.

Race: _________________

How often do you exercise? ____________________________________

Do you have a job that is physically demanding or requires manual labor (such as construction)? Yes / No

Appendix E

Demographic Scale

Demographic Questionnaire

Please fill in your information to the *best of your ability*. Participation is completely *voluntary*. All of this information is completely **CONFIDENTIAL** and will not be shared with anyone. Please seal all of your surveys in the envelope you were given *before* turning it in.

Please circle or mark your answers.

1) Date of Birth: ____/_____/______

2) Age: _____

3) Sex: Male Female Other **[3a-d removed for males]**

3a) If female, please list the first day of your last period (or closest guess)
___/___/____ Not Sure

3b) If female, are you pregnant?
Yes No Not Sure

3c) Are you currently taking birth control?
Yes No Not Sure

3d) If yes, please circle what type of birth control you are on: (circle all that apply)
The Patch The Ring The Shot
The Pill (oral contraceptive) IUD (intrauterine device)
Other: ______________

4) Year:

Freshmen (0-30hrs) Sophomore (31-60hrs)
Junior (61-90hrs) Senior (91+hrs)
Graduate Student Staff
Faculty Not student, staff, or faculty

5) Ethnicity: (Please circle one)
Caucasian, Non-Hispanic
African/Black American
Hispanic
Asian- Pacific islander
Native American
Multiracial or Other: ______________________________

6) Religious Affiliation:

Catholic | Christian (list denomination): ____________________

Buddhist | Hindu | Muslim | Pagan/Wiccan | Judaism

Atheist | Agnostic | Other: ________________________

7) Employment Status:

Student, Part–time only | Student, Full-time only

Student, Part-time & working part-time
(Less than 30 hrs working)

Student, Part-time & working full-time
(31+ hrs a week working)

Student, Full-time & working part-time

Student, Full-time & working full-time

Not a student, Unemployed or retired

Not a student, working part-time

Not a student, working full-time

If student only please skip 7a & 7b.

7a) If working please describe job: ______________________________

7b) Length of employment: ___ Days ____ Months ____ Years

8) Personal Income:

$0-$5,000	$20,001-40,000
$5,001-10,000	$40,001-80,000
$10,001-20,000	$80,000+

9) Household Income:

$0-$5,000	$20,001-40,000
$5,001-10,000	$40,001-80,000
$10,001-20,000	$80,000+

10) Personal education level: (Highest level *completed*)

K-8	Bachelor Degree
9-12	Master's Degree
Some College	PhD or Above
Associate Degree	Don't Know

11) Mother's education level: (Highest level *completed*)

K-8	Bachelor Degree
9-12	Master's Degree
Some College	PhD or Above
Associate Degree	Don't Know

12) Father's education level: (Highest level *completed*)

K-8	Bachelor Degree
9-12	Master's Degree
Some College	PhD or Above
Associate Degree	Don't Know

13) Sexual Orientation:

Heterosexual   Homosexual
Bisexual   Asexual
Other: ____________________
Don't Know

14) Living Arrangement:

Alone   With roommate(s)
With partner   With family

15) Number of Siblings:

0   1-2   3-4   5-6   7-8   9+

16) Number of people living with you in your home (including yourself):

1-2   3-4   5-6   7-8   9+

17) Pets living in your home: (Circle all that apply)

Yes: Dog(s)   Cat(s)   Bird(s)   Fish(es)   Reptile(s)   Rodent(s)
Other
No

Appendix F

Relationship Status Assessment Scale

Relationship Status Assessment Scale

1) Select the option that best represents your current dating status:

____ Married

___ Single (or divorced), but in a committed relationship

___ Single (or divorced), and casually dating

___ Single (or divorced), and not currently dating anyone

2) I Would **NOT** Date: Caucasians (White) (T / F)
3) I Would **NOT** Date: Black Americans (T / F)
4) I Would **NOT** Date: Hispanics (T / F)
5) I Would **NOT** Date: Asians (T / F)
6) I Would **NOT** Date: Biracial/Multiracial (T / F)
7) I Would **NOT** Date: Other race (please specify):______________

If you are not currently in a relationship, please skip 8.

8) How well do the following adjectives apply to **your current feelings about your romantic relationship**?

	Not at all 1	2	3	4	Somewhat 5	6	7	8	Very much 9	Don't Know	Refuse to Answer
Permanent											
Serious											
Stable											
Committed											
Secure											

Appendix G

Sexy Scent Scale

T-shirt Attractiveness Scale

Participant #: ___

T-shirt #: __________

1. How ***Strong*** is the smell of this shirt?

1	2	3	4	5	6	R
No Smell		Weak Smell	Mild Smell		Strong Smell	

2. How ***Pleasant*** does this shirt smell?

1	2	3	4	5	6	R
Very Unpleasant		Somewhat Unpleasant	Somewhat Pleasant		Very Pleasant	

3. How ***Sexy*** does this shirt smell?

1	2	3	4	5	6	R
Very Unsexy		Somewhat Unsexy	Somewhat Sexy		Very Sexy	

4. I would consider ***going on a date*** with the man that wore this shirt.

1	2	3	4	5	6	R
Strongly Disagree		Somewhat Disagree	Somewhat Agree		Strongly Agree	

5. I would consider having ***sexual relations*** with the man that wore this shirt.

1	2	3	4	5	6	R
Strongly Disagree		Somewhat Disagree	Somewhat Agree		Strongly Agree	

6. How did the smell of this shirt compare to the previous shirt?

1	2	3	4	R
Much Worse	Worse	Better	Much Better	

T-shirt Attractiveness Scale

Participant #: ___

Final thoughts about the smells

The ***most*** pleasant smelling shirt was: _______

The ***least*** pleasant smelling shirt was: _______

Additional comments, questions, or concerns:

____

____

____

____

____

____

Appendix H

Male Manipulation Check

Male Manipulation Check

Did you do any of the following behaviors over the last two days? (Circle all that apply)

1) Have Sex:	Y / N
2) Sleep in the same bed with someone	Y / N
3) Drink Alcohol	Y / N
4) Smoke	Y / N
5) Eat large amounts of:	
A) Garlic	Y / N
B) Onion	Y / N
C) Cumin	Y / N
D) Curry	Y / N
6) Hang out in smelly rooms	Y / N
7) Use:	
A) Deodorant	Y / N
B) Cologne	Y / N
C) Aftershave	Y / N
D) Perfume	Y / N
E) Soap that wasn't provided	Y / N

Appendix I

Instruction Sheet and List of Restrictions for Male Participants

Instruction Sheet & List of Restrictions for Male Participants

DO NOT WASH YOUR T-SHIRT FOR ANY REASON!

Instructions

Recruitment Day

Complete matching survey and contact information card.

Day 1 of Research

1. Come to lab
2. Briefing
3. Biodata collection (Finger prick and cheek swab)
4. Issue materials
5. Dismissed

Day 2 of Research

1. Continue following restrictions discussed in briefing and listed below

Day 3 of Research

2. Return to lab
3. Bring baggie materials were issued in and additional shirt
4. Place experimental t-shirt in baggie and put on additional shirt
5. Debriefing
6. Compensation
7. Final dismissal

Restrictions

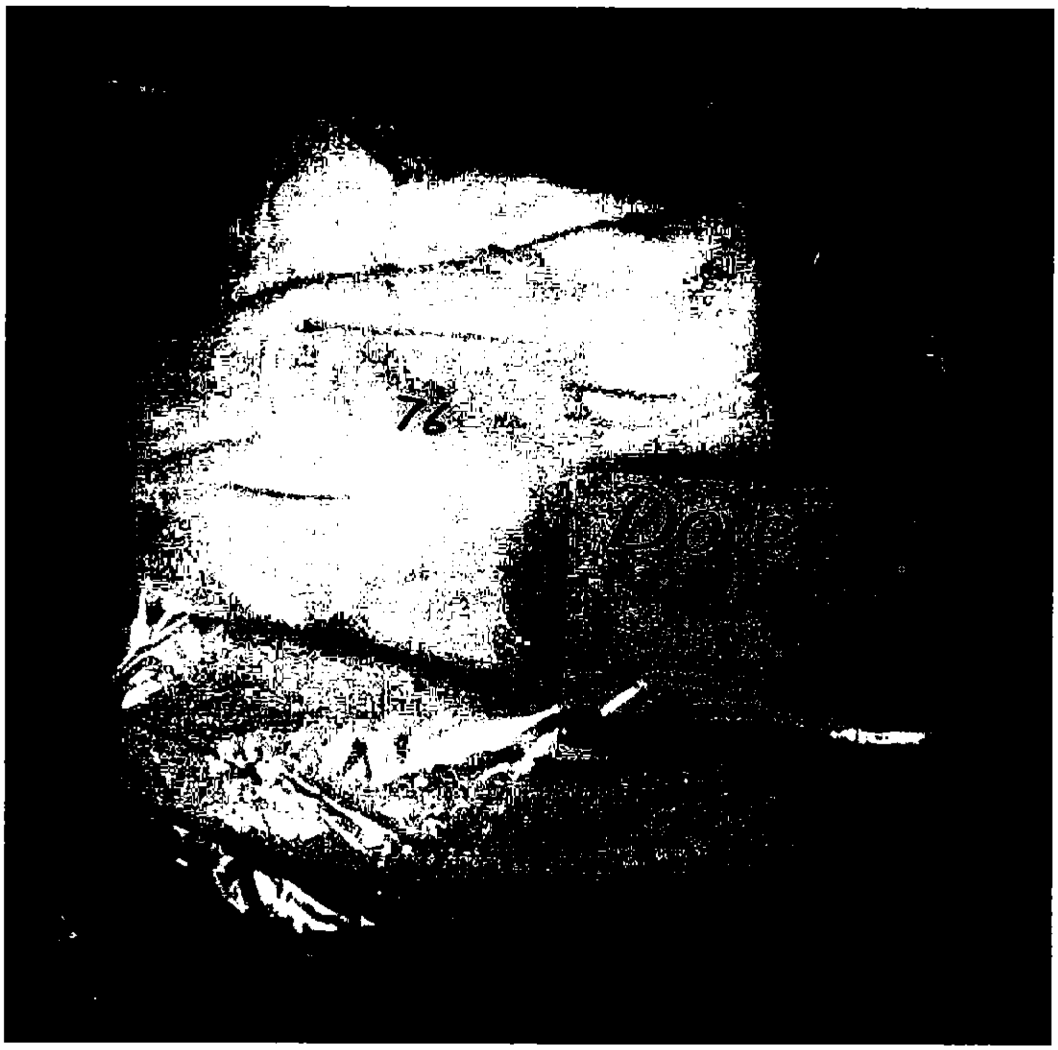
No Sex
    Sleep alone in bed (Strongly encouraged)
No Alcohol
No Smoking
Avoid foods with strong smelling ingredients used in large amounts
    Examples: Garlic, onion, cumin, curry, etc.
Avoid smelly rooms
No deodorant, cologne, aftershave, perfume, etc
Use unscented soap that was provided

Appendix J

Male Package

Male Package

Each male participant was issued the same package on the first day of the study. A Ziploc baggie had a shirt that had been marked on the inside of the bottom hem of the right side of the shirt with a number or mark that matched the baggie marking. In the example below, the shirt had a 76 written on the inside of the hem with a sharpie.

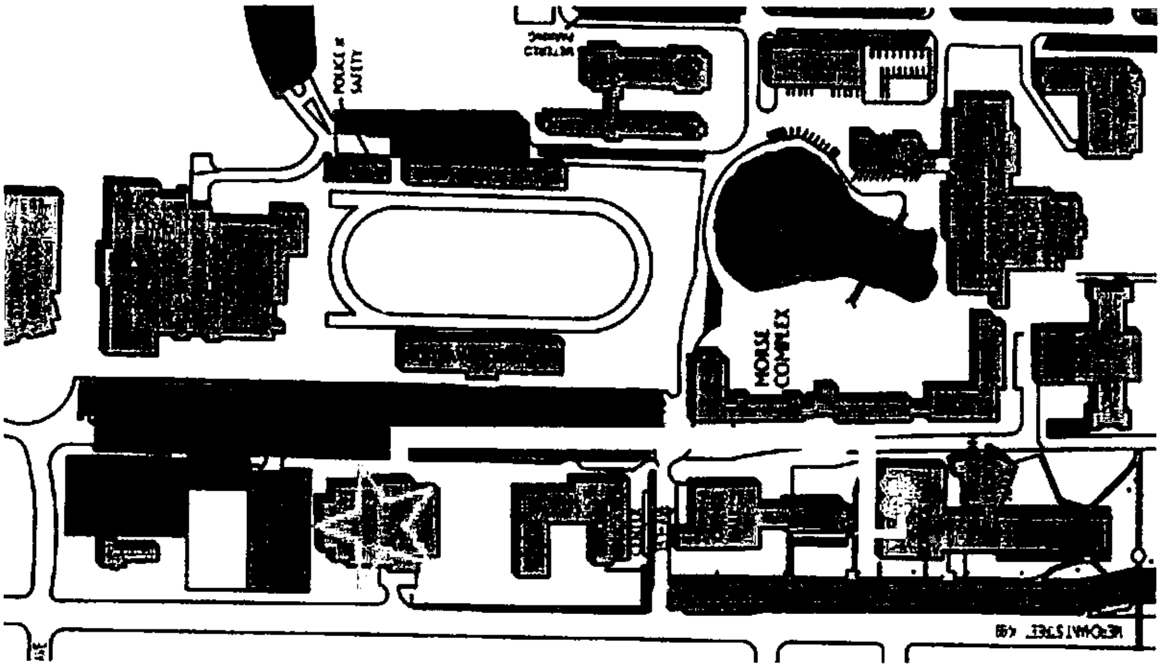


Appendix K

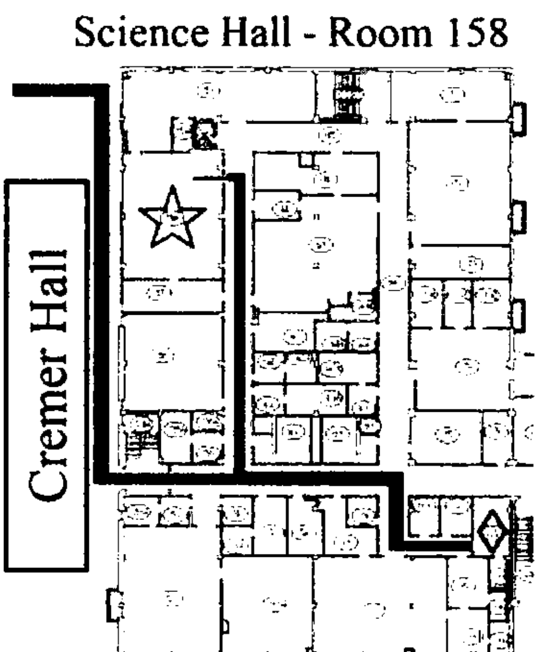
Maps for Participants

Maps

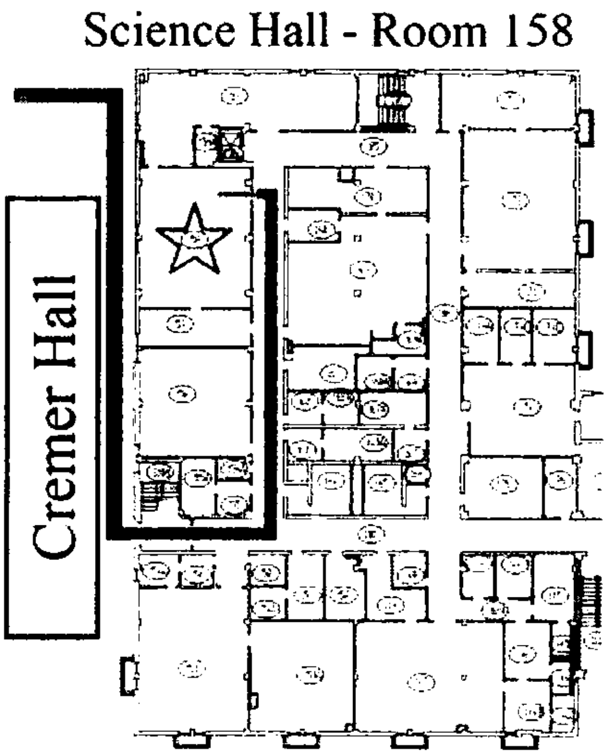
Campus Map



Building Map for Males



Building Map for Females



Appendix L

Floor Plan and Session Diagrams

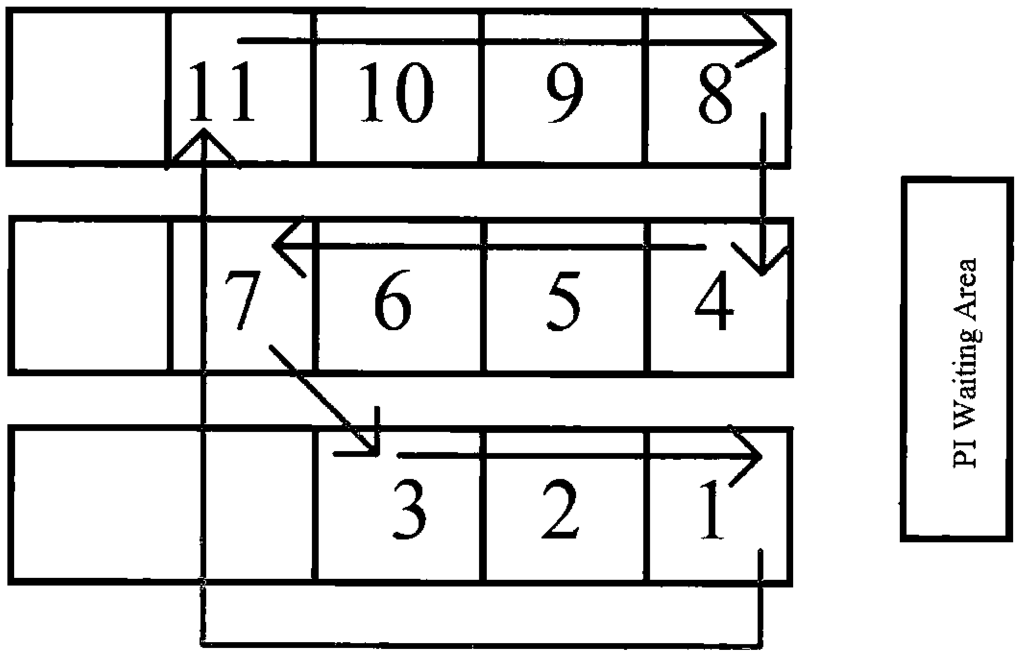
Floor Plan and Session Diagrams

The images included in this appendix are intended to provide additional clarity about the layout of the room and rotation the shirts.

Room Setup. This is a picture of the room set up for female participants. Each station has a laptop and box. The boxes not being used in the session were stored in the back of the room.

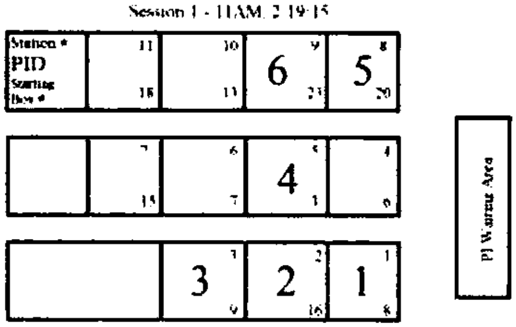
Master station and box rotation diagram. This diagram shows the layout of the stations without the blinders and the directions the boxes traveled during each session.

Diagram of Stations and Box Rotation Cycle

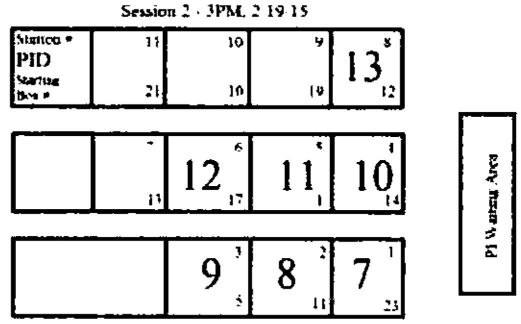


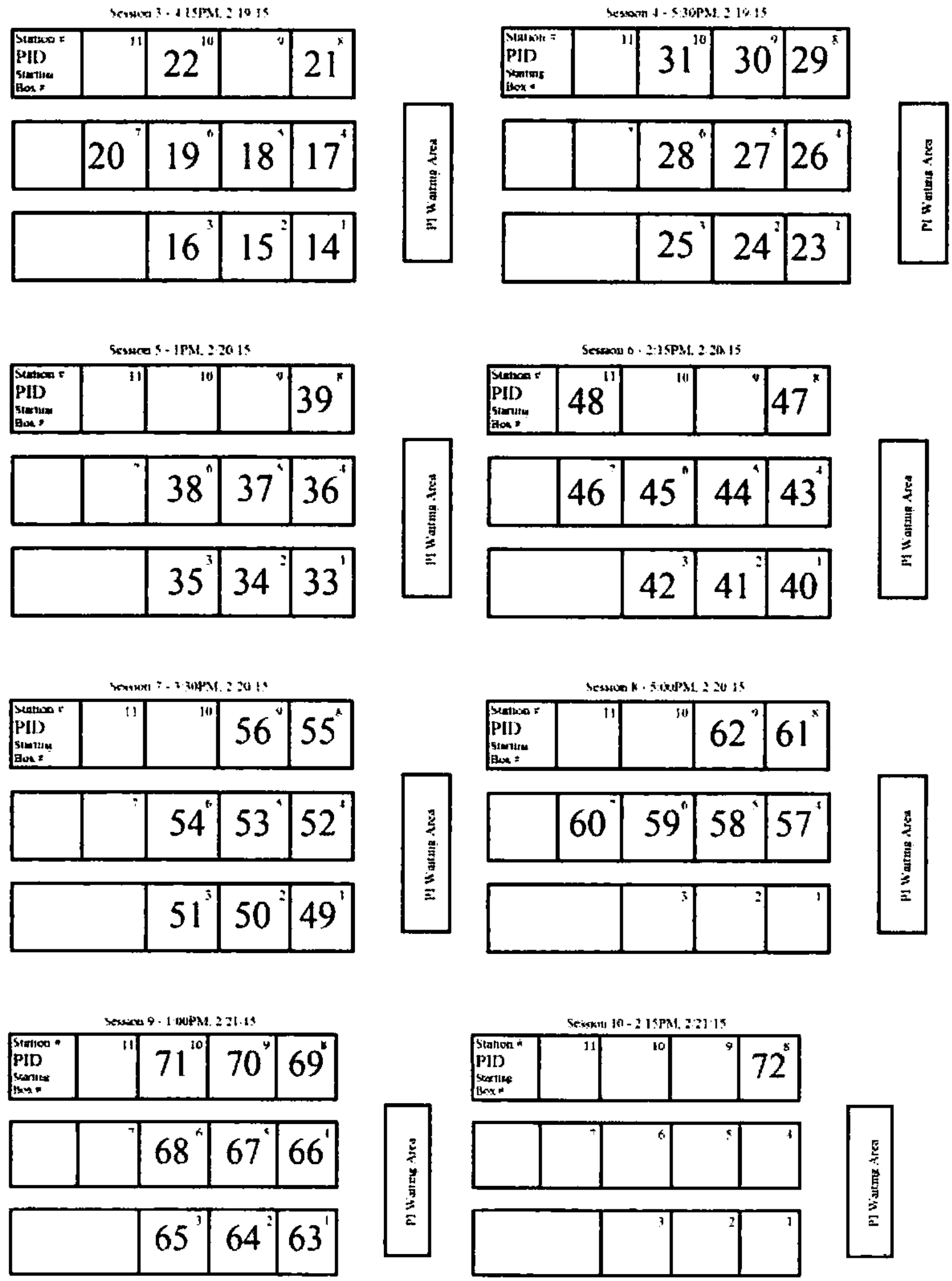
Session Images. Each diagram shows how the participants were spaced in each session.

Session 1 - 11AM, 2-19-15

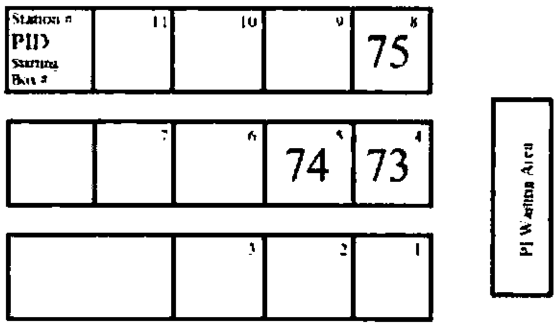


Session 2 - 3PM, 2-19-15




Session 3 - 4:15PM, 2/19/15
Session 4 - 5:30PM, 2/19/15
Session 5 - 1PM, 2/20/15
Session 6 - 2:15PM, 2/20/15
Session 7 - 3:30PM, 2/20/15
Session 8 - 5:00PM, 2/20/15
Session 9 - 1:00PM, 2/21/15
Session 10 - 2:15PM, 2/21/15
Station #
PID
Starting Box #
PI Waiting Area

Session 11 - 3:30PM, 2/21/15



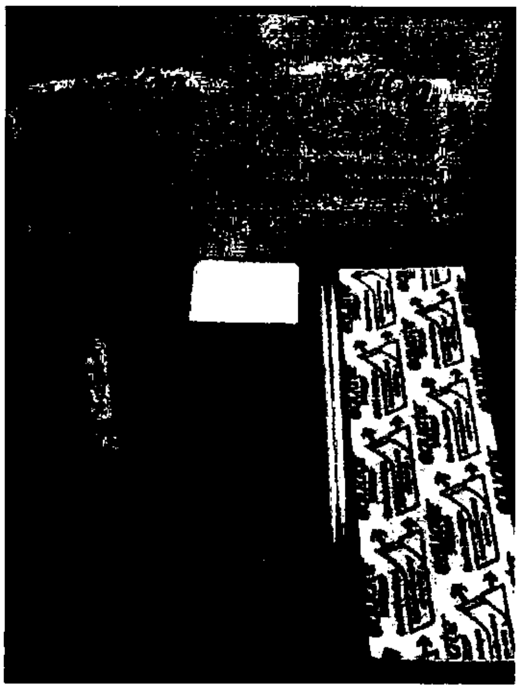
Appendix M

Blood Collection and Assessment Tools

Blood Collection and Assessment Tools

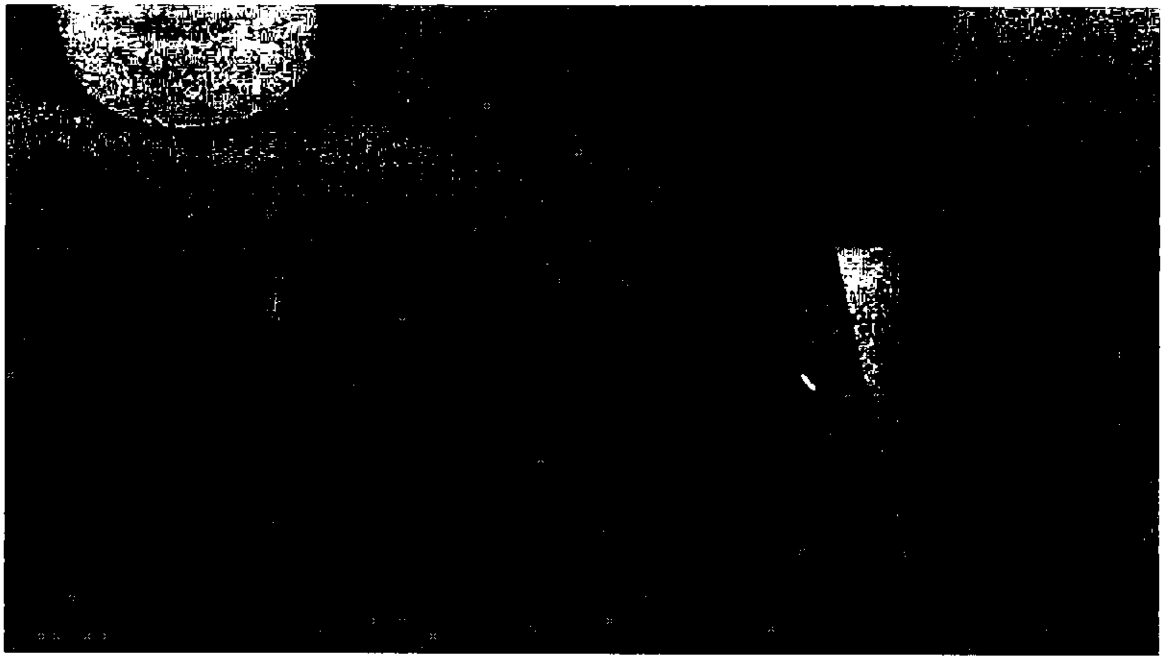
I used diabetic equipment to collect blood samples from participants. A frosted slide was marked with as wax pencil to separate the blood drops for analysis. Anti-sera was added to each drop and mixed with a toothpick.

Blood typing supplies. Two alcohol swabs, one thin lancet, one frosted slide, two toothpicks, and one Band-Aid.



Anti-Sera. The clear solution is the Rh factor (positive or negative). The yellow solution is the B factor. The blue solution is the A factor.

Example of completed blood typing. This participant is A+.



Appendix N

Blood Type Similarity Coding Tables

Blood Type Similarity Coding Tables

The tables included show the steps that I took to code blood type similarity. The first table shows how I coded each blood type for each agent that can present in blood. The second table shows a complete list of comparisons and the degree of similarity associated with it.

Table 1. Blood type coding.

Blood Type		Allele		
		A	B	+
1.	O-	0	0	0
2.	O+	0	0	1
3.	A-	1	0	0
4.	A+	1	0	1
5.	B-	0	1	0
6.	B+	0	1	1
7.	AB-	1	1	0
8.	AB+	1	1	1

Table 2. Blood type similarity comparisons.

	Person A		Person B's Blood Type							
#	Type	BT_ code	O- (8)	O+ (7)	A- (2)	A+ (1)	B- (4)	B+ (3)	AB- (6)	AB+ (7)
1.	A+	1	1	2	2	3	0	1	1	2
2.	A-	2	2	1	3	2	1	0	2	1
3.	B+	3	1	2	0	1	2	3	1	2
4.	B-	4	2	1	1	0	3	2	2	1
5.	AB-	5	1	0	2	1	2	1	3	2
6.	AB+	6	0	1	1	2	1	2	2	3
7.	O-	7	3	2	2	1	2	1	1	0
8.	O+	8	2	3	1	2	1	2	0	1

Appendix O

Frequency Tables for Demographic Variables

Frequency Tables

The frequency tables presented below are in the same order as the demographic scale. Each table has the response category, frequency, valid percent, and cumulative percent.

	Males			Females		
Age	*F*	VP	CP	*f*	VP	CP
18	3	13.6	13.6	23	31.9	31.9
19	2	9.1	22.7	23	31.9	63.9
20	4	18.2	40.9	5	6.9	70.8
21	4	18.2	59.1	11	15.3	86.1
22	2	9.1	68.2	3	4.2	90.3
23	2	9.1	77.3	4	5.6	95.8
24	0	0	77.3	1	1.4	97.2
25	1	4.5	81.8	0	0.0	97.2
26	1	4.5	86.4	0	0.0	97.2
27	1	4.5	90.9	0	0.0	97.2
28	1	4.5	95.5	1	1.4	98.6
29	1	4.5	100.0	0	0.0	98.6
30+	0	0	100.0	1	1.4	100.0
Total	22	100.0	100.0	72	100.0	100.0

	Males			Females		
Year	*f*	VP	CP	*f*	VP	CP
Freshman	6	27.3	27.3	30	41.7	41.7
Sophomore	6	27.3	54.5	25	34.7	76.4
Junior	5	22.7	77.3	11	15.3	91.7
Senior	4	18.2	95.5	6	8.3	100.0
Staff	1	4.5	100.0	0.0	0.0	100.0
Total	22	100.0	100.0	72	100.0	100.0

	Males			Females		
Race	*f*	VP	CP	*f*	VP	CP
White	12	54.5	54.5	53	73.6	73.6
Black	7	31.8	86.4	8	11.1	84.7
Hispanic	0	0.0	86.4	5	6.9	91.7
Asian	2	9.1	95.5	4	5.6	97.2
Native American	0	0.0	95.5	2	2.8	100.0
Other/Multi	1	4.5	100.0	0	0.0	100.0
Total	22	100.0	100.0	72	100.0	100.0

Employed	Males			Females		
	f	VP	CP	*f*	VP	CP
Not	14	63.6	63.6	33	45.8	45.8
Part-Time	6	27.3	90.9	33	45.8	91.7
Full-Time	2	9.1	100.0	6	8.3	100.0
Total	22	100.0	100.0	72	100.0	100.0

Religion	Males			Females		
	f	VP	CP	*f*	VP	CP
Catholic	1	4.5	4.5	19	26.4	26.4
Protestant	14	63.6	68.2	38	52.8	79.2
Agnostic	2	9.1	77.3	4	5.6	84.7
Atheist	3	13.6	90.9	2	2.8	87.5
Muslim	0	0.0	90.9	1	1.4	88.9
Sikh	0	0.0	90.9	1	1.4	90.3
Other	1	4.5	95.5	1	1.4	91.7
None	0	0.0	95.5	3	4.2	95.8
Refuse	1	0.0	100.0	3	4.2	100.0
Total	22	100.0	100.0	72	100.0	100.0

Personal Income	Males			Females		
	f	VP	CP	*f*	VP	CP
$0-5,000	14	63.6	63.6	51	70.8	70.8
$5,001 – 10,000	4	18.2	81.8	12	16.7	87.5
$10,001 – 20,000	0	0.0	81.6	0	0.0	87.5
$20,001 – 40,000	1	4.5	86.4	1	1.4	88.9
$40,001 - $80,000	1	4.5	90.9	0	0.0	88.9
$80,000+	0	0.0	90.9	0	0.0	88.9
Refuse	2	9.1	100.0	8	11.1	100.0
Total	22	100.0	100.0	72	100.0	100.0

Family Income	Males			Females		
	f	VP	CP	*f*	VP	CP
$0-5,000	0	0.0	0.0	4	5.6	5.6
$5,001 – 10,000	1	4.5	4.5	6	8.3	13.9
$10,001 – 20,000	1	4.5	9.1	5	6.9	20.8
$20,001 – 40,000	4	18.2	27.3	14	19.4	40.3
$40,001 - $80,000	6	27.3	54.5	15	20.8	61.1
$80,000+	3	13.6	68.2	12	16.7	77.8
Refuse	7	31.8	100.0	16	22.2	100.0
Total	22	100.0	100.0	72	100.0	100.0

Personal Education	Males			Females		
	f	VP	CP	*f*	VP	CP
K-8	0	0.0	0.0	0	0.0	0.0
9-12	4	18.2	18.2	9	12.5	12.5
Some College	10	45.5	63.6	51	70.8	83.3
Associates	7	31.8	95.5	3	4.2	87.5
Bachelor	0	0.0	95.5	8	11.1	98.6
Master	1	4.5	100.0	0	0.0	98.6
PhD or Above	0	0.0	100.0	0	0.0	98.6
Don't Know	0	0.0	100.0	0	0.0	98.6
Refuse	0	0.0	100.0	1	1.4	100.0
Total	22	100.0	100.0	72	100.0	100.0

Mother's Education	Males			Females		
	f	VP	CP	*f*	VP	CP
K-8	0	0.0	0.0	1	1.4	1.4
9-12	7	31.8	31.8	16	22.2	23.6
Some College	2	9.1	40.9	13	18.1	41.7
Associates	3	13.6	54.5	11	15.3	56.9
Bachelor	5	22.7	77.3	19	26.4	83.3
Master	4	18.2	95.5	6	8.3	91.7
PhD or Above	1	4.5	100.0	1	1.4	93.1
Don't Know	0	0.0	100.0	5	6.9	100.0
Refuse	0	0.0	100.0	0	0.0	100.0
Total	22	100.0	100.0	72	100.0	100.0

Father's Education	Males			Females		
	f	VP	CP	*f*	VP	CP
K-8	0	0.0	0.0	1	1.4	1.4
9-12	6	27.3	27.3	19	26.4	27.8
Some College	3	13.6	40.9	12	16.7	44.4
Associates	2	9.1	50.0	9	12.5	56.9
Bachelor	5	22.7	72.7	14	19.4	76.4
Master	3	13.6	86.4	5	6.9	83.3
PhD or Above	0	0.0	86.4	3	4.2	87.5
Don't Know	2	9.1	95.5	9	12.5	100.0
Refuse	1	4.5	100.0	0	0.0	100.0
Total	22	100.0	100.0	72	100.0	100.0

Sexual Orientation	Males			Females		
	f	VP	CP	*f*	VP	CP
Heterosexual	19	86.4	86.4	66	91.7	91.7
Homosexual	1	4.5	90.9	2	2.8	94.4
Bisexual	1	4.5	95.5	3	4.2	98.6
Asexual	1	4.5	100.0	0	0.0	98.6
Don't Know	0	0.0	100.0	1	1.4	100.0
Total	22	100.0	100.0	72	100.0	100.0

Living Arrangement	Males			Females		
	f	VP	CP	*f*	VP	CP
Alone	2	9.1	9.1	9	12.5	12.5
W Family	17	77.3	86.4	9	12.5	25.0
W Partner	3	13.6	100.0	7	9.7	34.7
W Roommates	0	100.0	100.0	47	65.3	100.0
Total	22	100.0	100.0	72	100.0	100.0

Siblings	Males			Females		
	f	VP	CP	*f*	VP	CP
0	2	9.1	9.1	2	2.8	2.8
1	9	40.9	50.0	24	33.3	3631
2	7	31.8	81.8	16	22.2	58.3
3	2	9.1	90.9	12	16.7	75.0
4	0	0.0	90.9	13	18.1	93.1
5	1	4.5	95.5	3	4.2	97.2
6+	1	4.5	100.0	2	2.8	10.0
Total	22	100.0	100.0	72	100.0	100.0

Household Size	Males			Females		
	f	VP	CP	*f*	VP	CP
1	3	13.6	13.6	7	9.7	9.7
2	9	40.9	54.5	20	27.8	37.5
3	3	13.6	68.2	14	19.4	56.9
4	5	22.7	90.9	16	22.2	79.2
5	1	4.5	95.5	6	8.3	87.5
6+	1	4.5	100.0	9	12.5	100.0
Total	22	100.0	100.0	72	100.0	100.0

Pets	Males			Females		
	f	VP	CP	*f*	VP	CP
No	15	68.2	68.2	30	41.7	41.7
Yes	7	31.8	100.0	42	58.3	100.0
Total	22	100.0	100.0	72	100.0	100.0

Appendix P

Shirt Order Lists

Lists of Shirt Groups and Orders of Presentation

High Physical Fitness Group (Shirts 1-12)

1. 3
2. 6
3. 8
4. 9
5. 7
6. 12
7. 5
8. 11
9. 1
10. 10
11. 4
12. 2

Low Physical Fitness Group (Shirts 13-22)

1. 13
2. 20
3. 15
4. 18
5. 16
6. 14
7. 17
8. 19
9. 21
10. 22

Shirts in order of presentation by session

Session 1

1. 8
2. 16
3. 9
4. 6
5. 3
6. 7
7. 15
8. 20
9. 23
10. 13
11. 18

Session 2

1. 21
2. 10
3. 19
4. 12
5. 13
6. 17
7. 1
8. 14
9. 5
10. 11
11. 23

Session 3

1. 23
2. 4
3. 18
4. 6
5. 16
6. 3
7. 15
8. 8
9. 22
10. 20
11. 2

Session 4

1. 17
2. 12
3. 23
4. 5
5. 21
6. 9
7. 14
8. 15
9. 11
10. 16
11. 7

Session 5

1. 15
2. 8
3. 23
4. 3
5. 20
6. 7
7. 18
8. 9
9. 13
10. 6
11. 16

Session 6

1. 12
2. 22
3. 23
4. 10
5. 19
6. 21
7. 11
8. 14
9. 1
10. 17
11. 5

Session 7

1. 4
2. 15
3. 3
4. 20
5. 6
6. 23
7. 8
8. 18
9. 2
10. 16
11. 13

Session 8

1. 5
2. 7
3. 17
4. 23
5. 12
6. 22
7. 21
8. 11
9. 19
10. 9
11. 14

Session 9

1. 21
2. 1
3. 22
4. 10
5. 23
6. 11
7. 19
8. 5
9. 17
10. 12
11. 14

Session 10		Session 11	
1.	8	1.	13
2.	15	2.	6
3.	23	3.	23
4.	16	4.	18
5.	9	5.	2
6.	13	6.	20
7.	3	7.	4
8.	20	8.	15
9.	7	9.	16
10.	18	10.	3
11.	6	11.	8

Appendix Q

Relevant Terminology

Relevant Terminology

Allele – One of two or more variants of a *gene* or *genetic marker*. Alleles occupy the same physical position on *homologous chromosomes* in the same or different individuals. (Page 9)

Allotypes – Antigenic markers on immunoglobulin chains (q.v.) or other serum proteins that are not common to all normal members of a species. For example, in humans 3 genetic variants of the kappa light chains are known that result from amino acid substitution at positions 153 and/or 191.

Antigen – Any substance foreign to the body that induces the proliferation of a specific *clone* of *antibody-producing B-cells*. (Page 20)

HLA – The M*HC* (major histocompatibility) complex of humans. It is located on *chromosome* VI and consists of a group of highly *polymorphic* (variable) linked genetic loci that determine the set of *glycoproteins* found on the surface of all *nucleated* cells in the body. They are unique to each individual and aid the body in identifying "self" from "nonself." In *autoimmune* diseases, this mechanism fails, and the body attacks itself. The HLA complex is also important in determining *transplantation* compatibility. (Page 180)

Idiotype – antigenic determinants characteristic of a particular variable domain of a specific immunoglobulin or T cell receptor molecule. The idiotype is a unique attribute of a particular antibody from a specific individual.

Immunology – The science dealing with immunity, serology, immunochemistry, immunogenetics, hypersensitivity, and immunopathology. (Page 161, King & Stanfords)
Immunology Defenses – Skin (Physical barrier) →innate immune responses→ adaptive

Isotype – Antigenic determinants shared by all individuals of a given species, but absent in individuals of other species.

Major Histocompatibility Complex (MHC) – A group of mammalian genes coding for the *glycoprotein cell surface markers* hat distinguish cell as "self." In humans, the complex is called the *human leukocyte-associated antigen* (*HLA) complex* and resides on *chromosome* VI. The locus consists of two sub-regions each containing multiple clustered copies of the MHC-I and MHC-II genes. MHC-1 proteins are present on every *nucleated* body cell, while MHC-II proteins are present only on *macrophages* and some *lymphocytes*. The HLA genes are the most polymorphic expressed human genes known, with as many as 50 *alleles* (variants) each. Very few, if any, humans have the same combination of alleles. When the MHC alleles in a population become less polymorphic such as in *inbred* zoo populations or *endangered species*, they become much more vulnerable to attack by viral or bacterial mimics. (Page 227-228)

MHC Class I – Intracellular (Viral)

MHC Class II – Extracellular (Bacterial)

Pathogen – Any organism that is capable of causing disease or a toxic response in another organism. Many bacteria, viruses, fungi and other microorganisms are pathogenic. (Page 276)

Polymorphism (genetic polymorphism) – The occurrence in a population (or among populations) of at least several variations (*alleles*) of a gene or *genetic marker*. Many genes that code for functional proteins exist in two (biallelic) or three (triallelic) forms but are unlikely to exhibit high rates of polymorphism. *Loci* (genetic locations) that have not been under evolutionary pressure to produce or regulate functional proteins may be extremely polymorphic, having sometimes hundreds of different variations at a single locus. These types of genetic markers have recently been exploited for the purpose of individual identification. (Page 297)

I, Lydia Njoroge, hereby submit this thesis to Emporia State University as partial fulfillment of the requirements for an advanced degree. I agree that the Library of the University may make it available for use in accordance with its regulations governing materials of this type. I further agree that quoting, photocopying, or other reproduction of this document is allowed for private study, scholarship (including teaching) and research purposes of a nonprofit nature. No copying which involves potential financial gain will be allowed without written permission of the author. I also agree to permit the Graduate School at Emporia State University to digitize and place this thesis in the ESU institutional repository.

Lydia Njoroge

Signature of Author

3/30/2015

Date

You stink so sexily: Sweaty T-shirts in Emporia.

Title of Thesis

Signature of Graduate Office Staff Member

Date Received