Physical Risk-Taking, Digit Ratio, and Circulating Testosterone

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ABSTRACT

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Using evolutionary psychology as a theoretical framework, the paper argues that extreme sports act as a vehicle for men to display social status and genetic fitness to prospective mates. Despite lacking an apparent utilitarian outcome, the behavior of skydivers can be seen as a costly signal given that parachute jumping requires substantial courage, athleticism, coordination, mental fortitude, and a willingness to take risks, all of which are characteristics deemed attractive to the opposite sex. We explore the biological basis of physical risk-taking by measuring skydivers' fluctuating testosterone levels and consequently, demonstrating an increase in their salivary testosterone concentrations following the act of parachuting. This hormonal change suggests that successfully engaging in a physical risk triggers an endocrinological response in men that is similar to the one triggered during competition. Testosterone is largely responsible for our species' sexual dimorphism, entailing that testosterone may also be responsible for the colossally unbalanced sex ratio in extreme sport participation. Developmental testosterone exposure measured through two biomarkers (second-to-fourth digit ratio and facial width-to-height ratio) were also taken into account in relation to extreme sport engagement. Finally, a survey examining the Sociosexual Orientation Inventory, Life History Theory as well as other psychological variables were included in the study. These scales are nomologically related to the theoretical foundation of the present research. A better understanding of what drives extreme sport engagement provides marketing practitioners and scholars a useful theoretical framework for understanding similar types of consumptions.

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INTRODUCTION

On May 16, 2015, the rock-climbing community grieved the death of the legendary Dean Potter, a visionary figure in the extreme sports that he practiced. Potter died at 43 while attempting a proximity wingsuit flight in Yosemite National Park after pushing the boundaries of free-solo rock-climbing, BASE (building, antenna, span, earth) jumping and slacklining for over 20 years (Bisharat, 2015; Branch, 2015; McSpadden, 2015). Potter was an extremist and he received plenty of criticism for taking outrageous and unnecessary risks. However, he is not alone, as extreme sports are increasing in popularity more than ever. Mountain climbing is one of the fastest growing outdoors pursuits and interest in skydiving, paragliding, whitewater kayaking and extreme skiing is at a steady growth (Pain and Pain, 2005). In Quebec alone, the Fédération Québécois de la Montagne et de l'Escalade (FQME) reported 2063 members at the end of 2015. Memberships increased by 10% in 2014 and by 12% in 2015, indicating an accelerated growth (FQME, 2014, 2015). The United States Parachute Association reported having 36,770 members, over 200 skydiving schools and estimated 3.2 million skydives at the end of 2014 (USPA, 2014). The Canadian Sports Parachuting Association (CSPA) reported 3527 membership renewals in 2016, which is a 12% increase from 2014 (CSPA, 2016). Furthermore, the "X Games" are summer and winter events for extreme sports developed and organized by the American TV Channel ESPN which have spread throughout the world (Pfister, 2011). The Burton European Open snowboarding competition in Laax, Switzerland, for example, is one of the major events in big air snowboarding, which consists of jumping from a ramp and performing tricks in the air. In 2010, 151 snowboarders competed in the half pipe (tricks and jumps) and 172 in the

slopestyle (tricks and jumps on a obstacle course) (Pfister, 2011). Finally, extreme races and obstacle courses such as *Tough Mudder* (Stein, 2012; Widdicombe, 2014), *Spartan Race* (Heitner, 2013), and triathlons (USA Triathlon, 2014) experienced widespread success. Meanwhile, there is a considerable sex ratio imbalance in extreme sport participation, with women representing a very small minority across disciplines (Pfister, 2011; USA Triathlon, 2014). For example, out of the total Canadian and US skydiving memberships only 18% (CSPA, 2016) and 13% (USPA, 2014) respectively are women. Similarly, females represent only 37% of FQME memberships (FQME, 2015) and less than a third of the Burton European Open snowboarding competition (Pfister, 2011). Perhaps the most telling sex ratio of all comes from the base jumping community where out of the 99 recorded deaths since January 2013, women represented only six fatalities (Świątek, 2016). This highly unbalanced sex ratio is consistent with several previous studies that demonstrated men's higher proclivity to take risks across a variety of domains, including health (Booth, Johnson, & Granger, 1999a), social, financial (Olsen & Cox, 2001), and especially physical risks (Byrnes, Miller, & Schafer, 1999; Wang, Kruger, & Wilke, 2009).

This paper offers a framework that can shed light on this sex ratio imbalance in extreme sports engagement. More specifically, it seeks the roots of what drives men to participate in these dangerous activities through the lens of evolutionary psychology. Men's penchant for physical risk-taking is rooted in their biology and serves as a means of displaying their fitness as potential mates to the opposite sex and to increase their status among peers. The extreme sports industry is then argued to piggyback on this phenomenon by providing several sports through which men can display their willingness

to take risks and, consequently, to market themselves as potential mates. This paper seeks to understand the mechanisms that drive the consumption of extreme sports in order to both provide a useful theoretical framework for marketing practitioners and to highlight the relevance and applicability of evolutionary theory in understanding consumer behavior. Because testosterone (T) is the major male sex hormone, we propose that it functions as a mediator for men's engagement in extreme sports. We speculate that men who engage in extreme sports were exposed to higher levels of T during gestation and that circulating T increases as a result of extreme sport engagement. To test this, we studied skydivers by measuring their circulating T as a function of parachuting out of a plane. We also measured two morphological markers of T, namely the second-to-fourth digit ratio (2D:4D) and facial width-to-length ratio (fWHR).

The paper is organized as follows. First we define what we mean by physical risk in the context of extreme sports consumption. Second, we examine sex differences in risk-taking by offering a synopsis of evolutionary psychology and some of its sub-theories as related to physical risk-taking. Third, we discuss T, two of its morphological markers (2D:4D and fWHR), and its relationship with risk-taking. Fourth, we report the results of an experiment that explores the relationship between the act of engaging in an extreme sport and individuals' endocrinological response. The experiment also seeks to determine the relationship between extreme sport engagement and the 2D:4D digit ratio, fWHR and several psychological scales related to sexuality, lifestyle and personality. Finally, we address the paper's limitations and contributions and we propose future research avenues.

THEORETICAL BACKGROUND

Physical Risk-Taking

Although researchers have different ways of defining risky behaviors, the consensus is that a goal directed behavior qualifies as an instance of risk-taking if two conditions are met: "(a) the behavior in question could lead to more than one outcome and (b) some of these outcomes are undesirable or even dangerous" (Furby & Beyth-Marom, 1992; as cited in Byrnes et al., 1999, p. 367). It is important to note that in the context of this paper, we do not judge the extremeness of a behavior based on its probability of resulting in injury or death. Rather, we judge it based on how much courage its participation requires. For example, in the USA the death rate from being involved in a road accident is 10.7 per 100 000 inhabitants or 15.8 per 100,000 licensed drivers (OECD/ITF, 2014, p. 506). The death rate for skydivers, on the other hand, is estimated at 0.047 per 100,000 skydivers (Bandolier, 2014). Combined, these statistics indicate that people are just as likely to die from performing one skydive as they are from driving 105 km. Nevertheless, while most individuals are hardly intimidated at the thought of getting behind the wheel of a car, the thought of jumping out of a plane would terrify the majority of people. Albeit safer, becoming a skydiver requires more courage and grit than becoming a driver. Before diving into the reasons why women are more risk averse than men, it is important to distinguish between different levels of explanations and to demonstrate their potential to be used in tandem when explaining behavior.

Proximate Versus Ultimate Explanations of Risk-Taking

To reach a complete understanding of a behavior, researchers must investigate it at different levels of analysis. "Proximate causes address how something operates

(causation) and its ontogenetic trajectory (development) while ultimate causes tackle the Darwinian forces that have shaped the evolution of the trait including its phylogenetic history (evolution) and its adaptive utility (function)." (Saad, 2016, p. 3). Previous studies looked at risk-taking and measured variables such as judged severity to explain why women are less likely to take risks. Women expect to obtain less enjoyment from engaging in risky recreational activities and they perceive higher chances of negative consequences as a result of engaging in the risky behavior (Harris, Jenkins, & Glaser, 2006). This, however, does not offer any explanatory value as to why women are more likely to judge risks more severely in the first place. Similarly lacking in explanatory power, when asked what is the appeal of engaging in extreme sports, athletes will typically justify their behavior by stating that they are driven by a sense of self-mastery, a sense of oneness with nature, or the increased humility and personal growth that are garnered in overcoming their fear (Brymer & Oades, 2009). As a BASE jumper states in Brymer and Oades'(2009) study, "We do these things for a number of reasons but one of the most powerful reasons for me is overcoming my own personal fears. That gives you so much more of an insight into your being into your potential and into your capacity." (p. 483). Although valuable, these proximate justifications do not explain why men experience these appeals in the first place. In other words, describing *how* one's mental and emotional processes work regarding a certain behavior does not offer the ultimate explanation of *why* the mental or emotional processes are there in the first place. To ask a BASE jumper why he jumps off cliffs is like asking a bowerbird why it builds such extravagant nests. The athletes can only offer an explanation that is available to them

through introspection. Evolutionary psychology provides the theoretical framework needed to tackle the ultimate explanations.

Evolutionary Psychology, Sexual Selection and Risk-Taking

This section covers the theoretical foundation of the paper and discusses risk-taking as a sexually dimorphic trait. Evolutionary Psychology (EP) is a young discipline that seeks to understand the ultimate causes of human behavior. It sees the brain as an adaptive organ equipped with a wide range of psychological mechanisms that are meant to solve specific problems that we faced as a species during the Pleistocene era. These problems were related to our survival and reproduction (Cosmides & Tooby, 1987; Miller, 2001; Pinker, 2002; Ridley, 1994).

Charles Darwin was the first to identify the two forces that work in tandem to drive the evolution of our minds and bodies, namely natural and sexual selection. Natural selection is the process through which sexually reproducing species transmit their heritable traits that possess survival benefits to their offspring. Individuals with such favorable traits are more likely than individuals lacking them to survive long enough to reproduce and pass on their favorable genes. Gradually, these favorable genes, and the traits associated with them, become more common in the respective population (Darwin, 1859). A telling example is the universal fear of heights (Menzies & Clarke, 1995). It is easy to understand how our height fearing ancestors were more likely to survive than their fearless counterparts who were more likely to fall off cliffs before passing on their genes.

Sexual selection acts on an organism's ability to successfully copulate with the opposite sex. It is a process that involves two mechanisms: intrasexual selection, during

which same-sex individuals compete for access to mates, and intersexual selection, during which individuals of one sex choose members of the opposite sex (Buss, 2003; Miller, 2001). For humans, the sex that typically engages in intersexual competition is male while the selector is female. Nevertheless, it is important to note that, along some traits, females also engage in intersexual competition to impress prospective suitors. The qualities or characteristics for which mates are selected are passed on to offspring because they provide individuals with reproductive benefits. Buss (2003), for example, explained that men strategically display their athletic aptitudes during courtship because they were historically selected as mates for possessing these traits.

The reason women are typically the selectors is rooted in the Parental Investment Theory (Trivers, 1972), which states that the sex that bears the greater cost of reproduction will be the most choosy when selecting a mate, while the sex that invests the least in reproduction will engage in greater competition for access to the more selective sex. Females need to invest a minimum of nine months of gestation, let alone the years of nurture and protection needed by their child to survive. Men's minimum required investment, on the other hand, is a mere copulation act. This reality is evident in our species' profound imbalance of available gametes. Women produce on average 400 ova in a lifetime while men produce between 15 and 200 million spermatozoa per 5 ml of semen (Cooper, Noonan, Von Eckardstein, Auger, Baker, Behre, Haugen, Kruger, Wang, Mbizvo, & Vogelsong, 2009).

In simple terms, while both men and woman care about producing quality offspring, men are more incentivized to seek additional mating opportunities at the expense of investing in current offspring. A telling reality is that the highest *recorded*

number of offspring parented by a woman is 69 while the highest *recorded* number for a man is 888 (Young, 1998). Because women are generally the choosier sex, they also have less variability in reproductive success. Evidence based on genetic tracing shows that women were more likely to reproduce than men. A staggering estimate is that throughout our evolutionary past, women were twice as likely to reproduce throughout their lifetime than men were (Baumeister, 2010; Shriver, 2005; Wilder, Mobasher, & Hammer, 2004).

In addition, out of the 1231 societies listed in the 1980 Ethnographic Atlas, 186 were found to be monogamous, 453 had occasional polygyny (multiple wives, one husband), 588 had more frequent polygyny, while only four had polyandry (multiple husbands, one wife) (Gray, 1998). These studies have great implications in regard to mating success and risk-taking. Namely, they indicate that a minority of men father children with multiple women while the majority of men fathered no children at all. In other words, men have much greater variability in reproductive success than females do. Emlen and Oring (1977, p. 215) concluded that "The greater the potential for individuals to monopolize resources or mates, the greater the intensity of sexual selection and the greater the environmental potential for polygyny." Given these conditions it is easy to understand how men's lower threshold for risk-taking has been shaped by sexual selection (Wilson & Daly, 1985; Buss, 1995).

A proclivity to take risks may yield greater reproductive success for males but not for females (for a detailed discussion see Buss, 2003). For example, if a man were to engage in an act that had a 10% risk of death and that would improve his likely reproductive success from the 40th percentile to the 80th percentile, then risk-taking would indeed be a rewarding trait. Ronay and Von Hippel (2010) demonstrated that high T

males, as indicated by the 2D:4D digit ratio, primed with low power, in terms of social status, are more likely to take risks compared to high T males primed with high power. The authors justified this finding by arguing that the low-power participants see risk-taking as a vehicle to pursue potential gains in the form of resources and status. Therefore, men are more likely to take risks because the potential reward is greater for them than it would be if women took the same risks, especially if men find themselves in an unfavorable low-status position. However, in addition to potentially deriving direct benefits from taking risks in the form of resources and status, men often go out of their way to signaling their mating fitness by displaying their willingness to take risks at the potential cost of serious injury or death. In our present society, extreme sports provide the vehicle for such displays.

Extreme Sports and Honest Signaling

Why would ostensibly rational individuals invest time, effort and money in an activity that not only lacks a utilitarian outcome but that also puts their lives in danger? Wingsuit BASE jumping, for example requires a tremendous amount of preparation and expenses of $16,000 USD in equipment and training. Furthermore, it is arguably the most dangerous recognized extreme sport. The worldwide estimated death rate for BASE-jumping is 1 in every 60 participants (Westman, Rosén, Berggren & Björnstig, 2008). Another study of 20,850 BASE jumps conducted in Norway reported one death for every 2,317 jumps and one non-fatal accident in every 254 jumps (Soreide, Ellingsen & Knutson, 2007). Why do men bother going through what may be considered life threatening and horrific experiences as a means of trying to impress women? Or rather, why are women weighing their mating choice based on their potential mate's willingness

to take risks in the first place? An evolutionary biologist, Amotz Zahavi (1975, 1995), who is best known for his work on the *handicap principle*, provides the answer. Zahavi wanted to explain evolved characteristics and behaviors that appear inconsistent with principles of natural selection because, like extreme sports, they appear to reduce fitness and endanger the survival of individual organisms. The most widely used example to depict the handicap principle is the peacock's tail. The peacock evolved such a metabolically costly and vulnerable feature to show its potential mates that despite this colorful and symmetrical handicap, the peacock is still able to nourish itself and to avoid predation, thus proving its genetic superiority. Peacocks with smaller, asymmetrical, or faded tails that indicate inferior genetic fitness would not pass the peahen's screening as viable mates. A willingness to take physical risks is similar to the concept of the peacock's tail, because it serves as an honest signal of genetic fitness (for a more detailed discussion, see Saad, 2007). Previous studies showed that women consider recreational risk-taking an attractive trait (Kelly & Dunbar, 2001; Wilke, Hutchinson, Todd, & Kruger, 2006).

Physical risk-taking is desirable because it signals strength, fitness, coordination, and athleticism. These traits have important survival value and are expected to be attractive to females when they are evaluating the opposite sex (Buss, 1989; Miller, 2001). Also, successfully outcompeting another male by engaging in an extreme sport can raise a male's social status. Similarly to how male rams bash horns with one another to gain mating opportunities so do men try to outperform each other to increase their social status and chances of mating.

In light of costly signaling, a field study conducted by Guéguen (2009) showed that men dressed in a firefighter uniform were far more likely to have young women 1) smile back when smiled at 2) return their greeting, and 3) give them their phone number, than when they were not wearing the uniform. Not only is it costly to be a firefighter in the sense that they must be in excellent physical condition to qualify as one, but they also risk injury and death. In addition, Baker and Maner (2009) conducted a study where they had men and women perform a behavioral measure of risk-taking called the Balloon Analogue Risk Task (Lejuez et al. 2002), during which they had to accrue as many points as they could by pumping up virtual balloons on a computer. Each pump represented a point, however, if a balloon was pumped too many times it exploded thus removing all the points gained from that balloon. The exploding threshold varied unpredictably for each balloon. Men with high self-reported romantic/sexual arousal took more risks when they were told that a celibate female (a confederate) would watch their performance. No such effect was observed in female participants. Similarly, Ronay and von Hippel (2010) demonstrated that male skateboarders at skateboarding parks engage in higher risks in the presence of a nubile woman. These increased risks led to more successfully performed tricks as well as more crash landings in the presence of the female but not the male confederate. The authors concluded that men use physical risk-taking as a sexual display strategy. The same study showed that men with higher T levels, measured by salivary assays, were even more likely to take higher risks in the presence of an attractive female. T, therefore, is an important variable to consider when studying risk-taking behavior. Next, we offer a brief overview of this hormone and the role it plays in sexual dimorphism.

Testosterone, Risk-Taking, and Dominance

Testosterone is a steroid hormone secreted by the testes in males. It belongs to the androgen group and it is the primary male sex hormone (Carlson, 2012). T plays a key role in the development of male reproductive tissues and in the development of secondary sexual characteristics during adolescence, including increased muscle and bone mass, growth of facial and body hair, penis enlargement, increased libido and deepening of the voice (Mooradian, Morley, & Korenman, 1987). On average, healthy adult males have T levels 9-10 times greater than healthy adult females (Torjesen, & Sandnes, 2004), and the daily production of the hormone is approximately 20 times greater in males, as they metabolize it at a faster rate (Southren, Tochimoto, Carmody, & Isurugi, 1965; Southren, Gordon, Tochimoto, Pinzon, Lane, & Stypulkowski, 1967). Prenatal T also has important effects on brain organization and future behavior. For example, Hines (2006) demonstrated that higher prenatal exposure to T yields substantial effects on sex-type play behavior and sex-type toy preferences. Higher levels of T are also associated with the pursuit of status, dominance, competition, violence and risk-taking in adult males (Stenstrom, Saad, Nepomuceno, & Mendenhall, 2011; for a review see Mazur & Booth, 1998). T plays an important role in male competition and dominance (Mazur, 1985, Mazur, 2005; Mazur & Boooth, 1998) and it acts both as a precursor and as a successor to social status (Archer, 2006). In other words, men with high T levels are more likely to be dominant and seek status compared to their lower T counterparts. Furthermore, having successfully increased their status, men experience a temporary rise in T. For example, Saad and Vongas (2009) had young males drive either a luxurious sports car (a status symbol) or an old family Sedan and showed that the participants driving the sports car

experienced a significant rise in T. We therefore propose that by successfully engaging in extreme sports, men will experience a similar surge in circulating T levels.

Hypothesis 1: Successfully performing a physically risky activity temporarily increases male participants' circulating testosterone concentration compared to their baseline testosterone levels.

In addition to circulating T, this paper seeks to examine the link between engagement in extreme sports and prenatal T exposure. T levels during gestation appear to have important organizational effects on the brain and for future sexually differentiated behavior (Archer 2006; Auyeung, Baron-Cohen, Ashwin, Enickmeyer, Taylor, Hackett, Hines, 2009; Udry, 2000). To determine the extent of T exposure during development, researchers have looked at biological markers of T, which is what we discuss next.

Morphological Markers of Testosterone

Second-to-Fourth Digit Ratio

Prenatal T exposure appears to reduce the growth of the second digit relative to the other fingers (Lutchmaya, Baron-Cohen, Raggatt, Knickmeyer, & Manning, 2004; Manning, Scutt, Wilson, & Lewis-Jones, 1998). Consequently, the second-to-fourth digit ratio (2D:4D) has been used as a proxy of both the exposure and sensitivity to prenatal T (Manning, 2002; Manning, Bundred, Newton, & Flanagan, 2003). This biomarker has been linked to an array of masculine behaviors such as aggression (Bailey & Hurd, 2005), perceived dominance (Neave, Laing, Fink, & Manning, 2003) and athletic ability (Manning & Hill, 2009). A masculinized 2D:4D digit ratio has also been linked to erotic

gift giving in men (albeit this correlation is moderated by mating confidence) and other courtship related consumption intended to acquire and retain mates (Nepomuceno, Saad, Stenstrom, Mendenhall, & Iglesias, 2016a; Nepomuceno, Saad, Stenstrom, Mendenhall, & Iglesias, 2016b). Interestingly, androgenized 2D:4D digit ratios predict masculine behaviors even among women (Brown, Finn, Cooke, & Breedlove, 2002; Clark, 2004; Paul, Kato, Hunkin, Vivekanandan, & Spector, 2006). Furthermore, Garbarino, Slonim, and Sydnor (2011) found that a lower 2D:4D ratio is associated with higher financial risk-taking in both men and women. The 2D:4D is also negatively correlated to traffic violations, indicating that the more androgenized a male is, the more likely he is to engage in riskier driving behavior (Schwerdtfeger, Heims, & Heer, 2010). Similarly, presumably due to a lower threshold for risk-taking, male financial traders with more androgenized 2D:4D ratios performed better than males with higher digit ratios (Coates, Gurnell, & Rustichini, 2009). However, a meta-analysis investigating the link between sensation seeking and 2D:4D ratio concluded that there is no reliable correlation (Voracek, Tran, & Dressler, 2010). Nevertheless, these studies did not sample extreme sports athletes. Therefore, we can argue that their analysis excluded the extreme end of the sensation-seeking scale. We hypothesize that if we look at skydivers, these individuals will have a lower 2D:4D ratio compared to a control group precisely because they represent the extreme end of the sensation-seeking spectrum.

Hypothesis 2: Both male and female extreme sports athletes have more masculinized digit ratios compared to their non-extreme sports counterparts.

Facial Width-to-Height Ratio

Recent work reported sexual dimorphism in facial width-to-height ratio (fWHR), with males showing higher fWHR than females (Carré & McCormick, 2008; Weston et al., 2007). A high fWHR has been associated with perceived facial masculinity (Roney, Hanson, Durante, & Maestripieri, 2006) and an array of behavioral traits in men that have also been linked to higher levels of T, including aggression (Carré & McCormick, 2008), financial risk-taking (Apicella, Dreber, Campbell, Gray, Hoffman, & Little, 2008), status-striving (Lewis, Lefevre, & Bates, 2012), and dominance (Lefevre, Lewis, Perrett & Penke, 2013). This association is believed to be caused by T (Carré & McCormick, 2008, Lefevre et al.,2013). We therefore expect skydivers to exhibit a higher fWHR as compared to a relevant control group.

Hypothesis 3: Both male and female extreme sports athletes have a higher facial width to height ratio compared to their non-extreme sports counterparts.

It is important to distinguish between the different measures of testosterone used in the study. The biomarkers (2D:4D and fWHR) indicate the degree of T exposure during development while the salivary concentration of T indicates an individual's circulating level of T at a given point in time. While the biomarkers reveal the developmental effects of T, they do not necessarily predict an individual's circulating level of T. In addition to morphological measures of developmental T exposure, we looked at psychological

variables that are relevant to our study. Given this paper's premise that men engage in extreme sports as a way to signal their mating value to the opposite sex, we were particularly interested in determining participants' behavior, attitude, and desire toward sexual relations. To do so, we had participants complete the revised Sociosexual Orientation Inventory (SOI), which we discuss next.

Sociosexual Orientation Inventory

The SOI is a self-reported questionnaire that measures individual differences in the tendency to have uncommitted sexual relationships (Simpson & Gangestad, 1991; Penske & Asendorpf, 2008). This construct is divided into three domains, namely: behavior (in terms of the number and renewal of casual sexual partners), attitude (regarding casual sex) and desire (for individuals not in a romantic relationship) (Penke & Asendorpf, 2008). Because we look at extreme sports in the context of sexual signaling, we expect skydivers to score higher on the SOI scale.

Hypothesis 4: Both male and female extreme sports athletes score higher on the SOI scale compared to their non-extreme sports counterparts.

This prediction is in line with our literature review because we assume that skydivers are successful in signaling their reproductive fitness and are deemed as more attractive to women. A higher libido and multiple sex partners are also associated with higher T levels in men (Bogaert & Fisher, 1995; van Anders, Hamilton, & Watson, 2007). Furthermore, to support the assumption that male skydivers engage in their sport in part as a means to

attract women, we want to show that they are more concerned with and devote more resources towards reproductive gains. Life History Theory provides the necessary theoretical framework to do so, a topic addressed in the next section.

Life History Theory

Life History Theory is a sub-theory from evolutionary biology that seeks to understand an organism based on its allocation of bioenergetics and material resources (Figueredo, Vásquez, Brumbach, Schneider, Sefcek, Tal, Hill, Wenner & Jacobs, 2006). Generally, these resources will either be invested toward an organism's somatic effort to promote its growth and its continued survival or toward a reproductive effort to promote the production of offspring, or vehicles for survival of the organism's genes (Figueredo et al., 2006). Consequently, a life history strategy allocates an individual's bioenergetic and material resources among the competing demands of survival and reproduction (Shennan, 2002). We expect skydivers to lean more in favor of a life history strategy in which they allocate resources toward reproductive efforts compared to the control group comprised of non-extreme sports athletes. To test this, we used the Mini-K scale (Figueredo, Vásquez, Brumbach, Sefcek, Kirsner & Jacobs, 2005) which measures an individual's K-factor. High K characteristics can take the form of long-term thinking, monogamy, extensive parental investment, substantial social support, adherence to social rules and careful consideration of risks, whereas low K characteristics may be manifested as impulsivity, short-term thinking, promiscuity, limited or no parental investment, little social support, disregard for social rules and extensive risk-taking (Bogaert & Rushton, 1989; Ellis, 1988; Figueredo et al., 2005; Rushton, 1985, 1987; Geary, 2002; Rushton & Bogaert, 1988; Thornhill & Palmer, 2004).

Hypothesis 5: Both male and female extreme sports athletes will scores lower on the mini-k scale compared to their non-extreme sports counterparts.

Next, we discuss the participants that that we used in the study as well as the data collection process.

METHODOLOGY

A group of 56 skydivers (12 women) were recruited from a local skydiving club in Quebec. All participants were solicited in person on weekends during six cumulative days throughout the summer of 2015. By participating, the skydivers agreed to complete a survey either in person or sent through email. The survey included demographic information, questions related to their experience with skydiving and the following scales: Ten-Item Personality Inventory (TIPI) (Gosling, Rentfrow & Swann, 2003), the 12-Item Grit Test (Duckworth, Peterson, Matthews, & Kelly, 2007), the Revised Sociosexual Orientation scale (SOI-R) (Penke & Asendorpf, 2008), the Mini-K scale (Figueredo et al., 2006) and the Sensation Seeking Scale Form V (SSS-V) (Zuckerman, 1979). Although only the SOI-R and the Mini-K scales are relevant to our hypotheses, the questionnaire included the additional scales for exploratory purposes. Aside from the questionnaire, participants had a headshot taken of them in order to measure their fWHR, and their hands were scanned to determine their 2D:4D digit ratios.

In addition, the males, exclusively, were asked to provide a baseline sample of

saliva in a plastic tube (item number 62.558.201 from Sarstedt product catalogue [www.sarstedt.com]) before performing their first skydive of the day. This salivary sample was used to determine men's circulating T levels. We excluded women from this measure because we do not expect them to experience a significant change in circulating T following the engagement in physical risk. This reasoning lies behind men's naturally higher inclination toward risk-taking, dominance, and physical aggression than women's, a phenomenon popularized as "the young male syndrome" (Wilson & Daly, 1985). This phenomenon is supported by studies on T, which plays a much smaller role in women's endocrinology (Torjesen & Sandnes, 2004; Southren et al., 1965; Southren et al., 1967), and which has been associated with the "young male syndrome" traits (Stenstrom et al., 2011; for a review see Mazur & Booth, 1998). Monitoring T levels in saliva has been shown to be a reliable tool used for decades in scientific research (Baxendale & James, 1984; Dabbs, 1990, 1991, 1992, 1993; Dawes, 1974; James & Baxendale, 1984; Lipson & Ellison, 1989; Navazesh, 1993; Saad & Vongas, 2009; Schurmeyer & Nieschlag, 1984; Vittek, L'Hommedieu, Gordon, Rappaport, & Southren, 1985). All baselines were collected after 11AM to avoid interference from males' natural morning peak of circulating T. The speed on the wind did not play a factor in the data collection as the skydiving club prohibited parachuting when the meteorological conditions were deemed unsafe for proper control of the canopy. Each participant was asked whether or not they consumed tobacco, brushed their teeth, or consumed a large meal within the previous hour and whether they were exposed to sexual stimuli or ejaculated within the past 12 hours. If any of them answered "yes", they were excluded from the study because these variables could bias the detected concentration of salivary T (Attia, el-Dakhly, Halawa,

Ragab, & Mossa, 1989; Lindman, Järvinen, & Vidjeskog, 1987; Dabbs, 1997; Dabbs & Mohammed, 1992; Redouté et al., 2000). Otherwise, they were given a consent form and were asked to provide a baseline sample of saliva. Approximately 15 minutes after landing from their first jump, participants were asked to provide a second sample of saliva. Some participants provided an additional third sample after their second skydive, which was used to test for a habituation effect. Our reasoning was that once the participants performed a skydive they would become more accustomed to the sensation of free-fall and will have weaker physiological reactions from the same free-fall stimulus on subsequent jumps. We conducted a pretest with eight male skydivers to determine what the optimal waiting time is for collecting the post-jump assay. Determining the waiting time to collect the post-jump assay is essential to capture the hypothesized temporary increase in circulating T, which is measured in pictograms per mililitre (pg/mL). We therefore collected a baseline assay before their first jump (Tbase), one 15 minutes after landing their first jump (T15) and one 30 minutes after their landing (T30). The mean salivary T concentration at Tbase was 163.31 pg/mL, the one at T15 was 194.59 pg/mL, and the one at T30 was 165.55 pg/mL. A one-tail repeated measures t-test showed that only the salivary T concentration at T15 was significantly higher than the one at Tbase ($p=.011$), thus indicating that 15 minutes is an adequate waiting time to capture the post-jump increase in fluctuating T. The salivary assays from the pretest participants were included in the analysis of the final sample. The pretest also indicated that waiting 30 minutes after landing to collect saliva would not yield a difference in circulating T levels because the salivary T levels at T30 were very similar to the ones at Tbase, as indicated by a t-test ($p=.447$). All of the saliva samples were immediately

labeled and frozen on-site at approximately -20 degrees Celsius. They were subsequently transported to Dr. Dominic Walker's laboratory at the Douglas Mental Health University Institute in Montreal, where they were analyzed for T concentration. Dr. Walker's laboratory was closed on the weekends and there weren't any means of storing the salivary assays at the laboratory during closing hours. Given that the assay collection took place on the weekend, the researcher had to return to the skydiving center during the week to pick up the collected assays and deliver them to the laboratory. The samples were transported by car or motorcycle in an ice cooler within nine days post collection. The time spent outside of a freezer (but inside the cooler) during transportation was no more than one hour. This time lapse is not nearly sufficient to threaten the integrity of the assays (Dabbs, 1991).

The researchers installed two stations in the lounge of the skydiving center to collect the morphological measurements. At the first station, all participants were asked to have their hands scanned using an Epson Workforce 320 scanner (see Figure 1). Only 30 out of the 43 males provided hand scans whereas all of the 12 females did so. This was due to time restriction on the part of some of the participants given that some of them were in a rush to leave the skydiving center. None of the participants had fractured index or ring fingers that might bias their natural 2D:4D ratio. These scans were digitally measured using the software PixelStick (http://plumamazing.com/mac/pixelstick). The 2D:4D ratios, corresponding to the index and ring fingers, respectively, were calculated using the distance measured in the number of pixels between the middle point of the basal crease and the tip of the ring and index fingers (see Figure 2). The ratios were calculated for both hands.

Figure 1: The hand scanning station

The research assistant is scanning a participant's hands to determine their 2D:4D digit ratio in the lounge of the skydiving center.

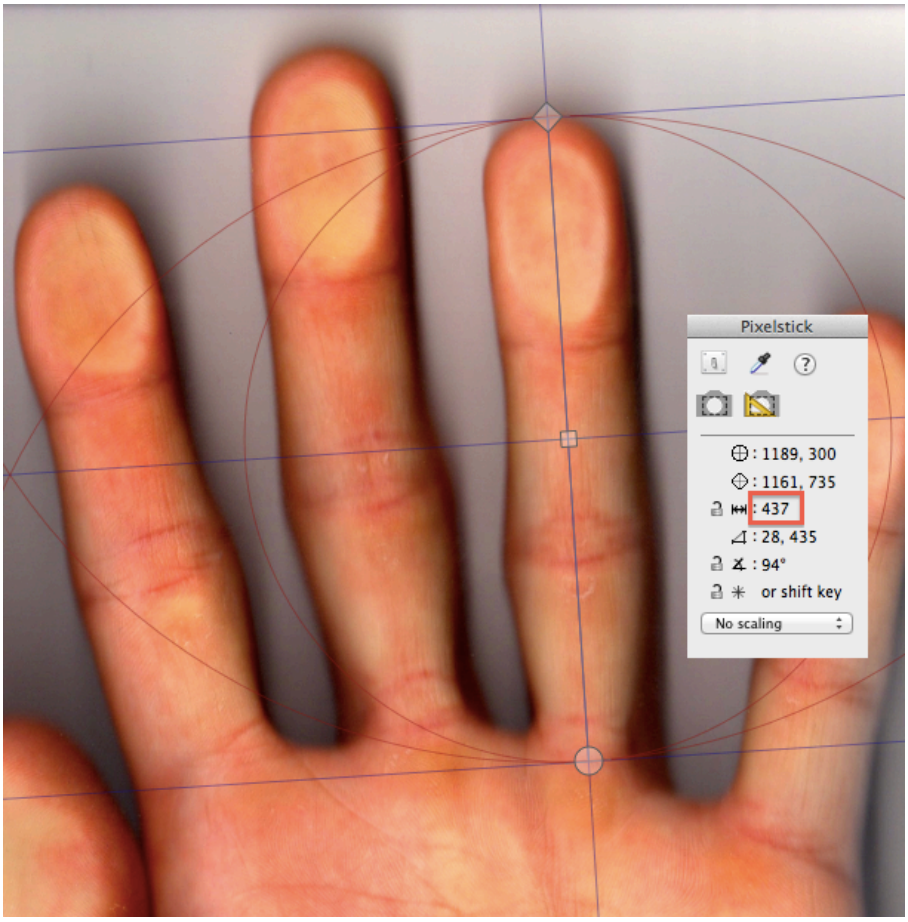

Figure 2: Measuring the 2D:4D finger ratio from a digital scan

After scanning the hand, the ring and index fingers were measured using the software PixelStick. The distance between the medial point of the finger's basal crease and its tip is provided in the number of pixels (highlighted in red). Once both fingers are measured, the 2D:4D ratio can be determined.

At the second station, all participants were then photographed for a "passport-type" photo on site to measure their fWHR. They were instructed to keep a neutral facial expression and to face the camera directly. The background was a blank wall. Photographs were taken using the camera of a Samsung Galaxy S4 cellular phone. Facial width was determined by measuring the distance between the left and right zygion and facial length was determined by measuring the distance between the upper lip and the eyebrow (see Figure 3).

Figure 3: Measuring Facial Width-to-Height Ratio

Facial widh-to-height ratio was determined by dividing the distance between the left and the right zygion (represented by the length of the rectangle) by the distance between the upper lip and the eyebrow (represented by the height of the rectangle). The distances were measured in number of pixels using the software PixelStick.

Once these morphological measurements were taken participants filled out the previously discussed questionnaire (see Appendix A). They had the option of completing a printed version on the spot or an online version at their convenience. Seven participants from the skydiving (experimental) group and 44 participants from the control group opted to complete the survey online.

Control participants were comprised of university students who regularly engage in non-extreme physical activities. The non-extreme sport population functions as an adequate comparison group for skydivers because, by using them, we can control for the effects of an active lifestyle. In other words, we can be confident that any observed effects in our study are not the result of participants' active lifestyle, but rather the result of their engagement in an extreme sport. The control participants were recruited during the month of December 2015 and January 2016 from Concordia University and McGill

University. The researcher installed a table with a poster advertising the research at the entrance of the universities' fitness centers and solicited participants accordingly (see Figures 4 and 5).

Figure 4 (above): Participants completing the questionnaire at Concordia University after having a photograph taken of their face and hands.

Figure 5: The set-up at McGill University (similar to the one at Concordia University) for collecting data from control participants.

To qualify, individuals had to exercise regularly and to not take part in any extreme sports. After a brief description of the study, willing participants were asked to sign a consent form and to allow the researcher to take a photo of their face and hands. To improve the accuracy of finger measurements, participants' hands were photographed using a Samsung Galaxy S4 cellular phone camera through a glass panel (see Figure 6). This method proved to be more efficient in terms of time and image quality (Neyse & Brañas-Garza, 2014). The reason this method was not used with the experimental group is because the researchers did not have access to a glass panel at the skydiving center. Similar to the experimental group, control participants were in addition asked to pose for a headshot and were given the option to complete a hard copy of the same survey on the spot or a digital copy later at their convenience. Rather than answering questions related to skydiving, control participants were asked to provide information regarding the frequency and intensity of engagement in their non-extreme sport (see Appendix B). The control group was composed of 92 participants (24 females).

Figure 6: Alternative method of measuring 2D:4D

With proper lighting, taking a photograph through a glass panel can be a much faster way to collect hand images and can provide a clearer image to determine digit ratios.

Once the data collection process was completed, the researcher added the scores of the scales from the survey and measured the fWHR and 2D:4D digit ratios of every participant. The following discussion focuses on data analysis, findings and results.

RESULTS

It was not possible to collect data on all of the variables from all subjects of the study. Due to subject attrition, effective sample size varied slightly across variables. For example, the number of data points for one measure (e.g. fWHR) may differ from the number of data points collected in another measure (i.e. the SOI-R scale) (See Table 1). The relevant analyses and results are covered in the order in which our hypotheses were posited.

Table 1: Overall data for both experimental and control groups.

	Males						Females					
	Skydivers			Control Athletes			Skydivers			Control Athletes		
	N	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**
Age	42	32.9	10.61	47	24.6	7.12	11	32	11.28	27	25.5	9.44
Left 2D:4D digit ratio	29	0.96	0.02	62	0.95	0.04	12	0.95	0.02	30	0.97	0.04
Right 2D:4D digit ratio	28	0.97	0.03	62	0.95	0.04	12	0.96	0.02	30	0.98	0.04
facial WHR	41	1.73	0.13	62	1.76	0.1	12	1.72	0.1	22	1.74	0.1
SOI Global	34	4.61	0.79	44	4.71	1.84	12	4.43	0.48	27	3.48	1.64
SOI Behavior	34	3.26	1.71	44	3.08	2.21	12	2.67	1.46	27	2.53	1.67
SOI Attitude	35	5.59	2.13	44	5.69	2.38	12	4.64	1.59	27	5.1	2.7
SOI Desire	35	4.28	2.17	43	5.41	2.1	12	2.79	1.38	27	2.78	1.44
Mini-K (Life History)	33	0.68	0.61	44	0.99	0.65	12	1.36	0.32	27	1.25	0.54
Extroversion	35	4.09	1.59	42	4.76	1.46	12	4.76	1.48	27	4.24	1.64
Ageeableness	34	4.65	1.05	43	4.7	1.1	12	5.38	5.38	27	4.89	1.23
Conscientiousness	35	4.87	1.31	43	5.26	1.16	12	5.58	0.9	27	5.56	1.42
Emotional Stability	35	4.95	1.51	43	4.91	1.38	12	4.85	1.35	27	4.59	1.3
Openness	35	5.09	1.14	43	5.57	1.04	12	5.23	1.41	27	5.54	1.17
Grit Test	34	3.6	0.43	43	3.44	0.59	11	3.73	0.43	26	3.52	0.73
SSSV	34	24.18	4.81	32	22.27	6.17	11	23.77	5.65	20	20.18	6.78
In romantic relationships	40	60%	n/a	48	31%	n/a	12	75%	n/a	27	52%	n/a
Length of relationship (years)	24	6.3	94.66	14	2.1	33.8	9	6.7	117.32	14	4.2	76.65

Table 2: Scales with descriptions

Scale	Description
Sociosexual Orientation Inventory V (SOI-V)	Measures individual differences in the tendency to have uncommitted sexual relationships. It is comprised of 3 facets: behavior, attitude, desire.
Mini-K	Measures the extent to which individuals allocate their energy and resources on either somatic or reproductive pursuits.
Ten-Item Personality-Inventory (TIPI)	Brief measure of the Big-Five personality traits
Grit Test	Measures individuals'' grit.
Sensation Seeking Scale form V (SSS-V)	Measures individuals' proclivity to seek varied, novel and complex intense feelings and experiences.

Circulating Testosterone

To test H1, we included the salivary assays from the pretest in the analysis of the subsequently collected salivary assays. Salivary samples of T concentrations were collected from 40 out of the 43 male skydiving participants approximately 15 minutes (T15) after landing their first skydive of the day. These samples were compared to participants' baseline levels (Tbase) collected prior to their jump. The remaining skydivers were unable to provide salivary samples due to time constraints or had recently consumed tobacco or pornography which have been shown to influence circulating T levels (Attita et al., 1989: Dabbs, 1997; Dabbs and Mohammed, 1992; Redouté et al., 2000). Seventy-two point five percent of the participants experienced a directional increase in circulating T, measured in pg/mL, at T15 compared to the one at Tbase. The mean baseline concentration of salivary T was 148.12 pg/mL (SD=60.36) while the post

jump concentration was 161.22 pg/mL (SD=64.62) (see Table 3 and Figure 7). However a repeated measure one-tailed t-test between the baseline and the post first jump saliva T concentrations reveals a p-value of .063 which suggests that the probability of observing a mean difference given the null hypothesis is not very small.

We calculated the differences of T concentrations before and after participants' jump (Tindex) and plotted these values on a normal distribution (see Figure 8). The graph indicates two potential outliers in the sample, namely an unexpected post jump difference of salivary T concentration of -172.7 pg/mL (participant 54) and one of -116.7 pg/mL (participant 19). We were unable to identify any methodological errors during the collection of their saliva nor did we identify any outlying score from the additional collected data associated with these two participants that might offer any explanation for these unexpected values. Based on an absolute Z-score value cut-off of 3, we can eliminate the data points from participant 54 based on its Z-scores of 3.52 but not the data point from participant 19, who has a Z-score of 2.46. Excluding the outlier, the new means of salivary concentrations from the baseline and the post jump samples are 145.34 pg/mL (SD=58.50) and 163.20 pg/mL (SD=64.22) respectively (see Table 3). A repeated measure one tail t-test indicated that the post jump salivary T concentrations are significantly higher than the baseline concentrations ($p<.01$), thus providing strong support for H1. It is worth noting that participant age was not correlated with their fluctuating T levels (Pearson's $r=.091$; $p=.621$, two-tailed).

Table 3: Skydiving males' baseline and post jump T concentrations.

	Mean	SD	N
Baseline	148.12	60.36	40
Post jump	161.22	64.62	40
Mean difference	13.10		
One-tailed t-test	p=.063		
95% Confidence Interval	Lower	Upper	
	-3.80	29.99	
Below is the same data after eliminating an outlier (with a z-score of -3.52) based on a Z-score cut-off smaller than -3 or bigger than 3			
	Mean	SD	N
Baseline	145.34	58.5	39
Post jump	163.2	64.22	39
Mean difference	17.86		
One-tailed t-test	p=.007		
95% Confidence Interval	Lower	Upper	
	3.61	32.11	

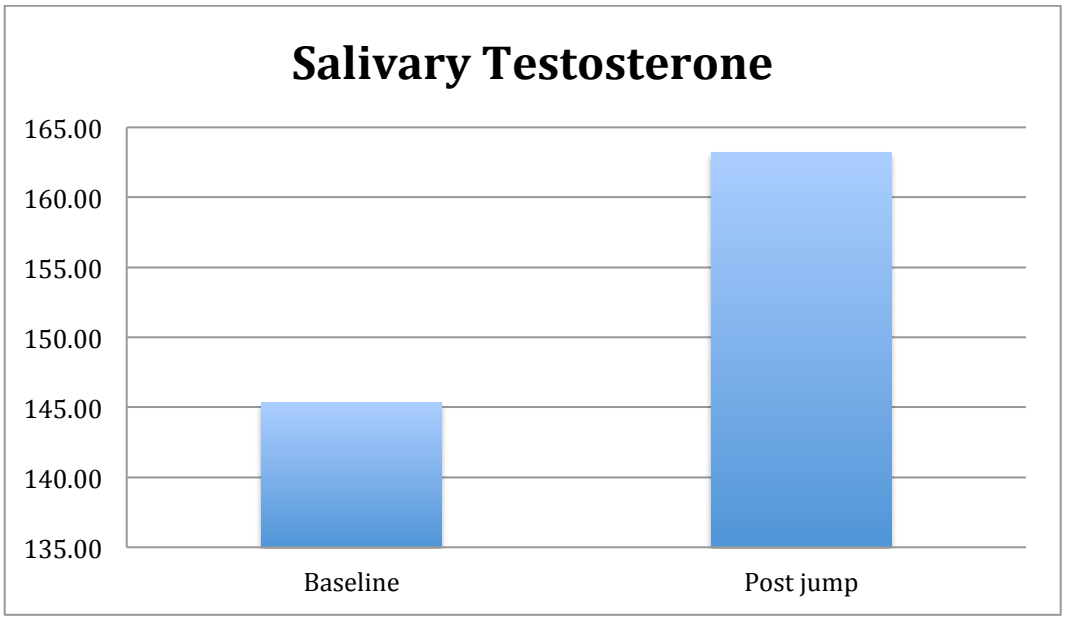

Figure 7: The average salivary T concentration of skydiving males measured at baseline and after their first jump. The data excludes the outlying participant 54.

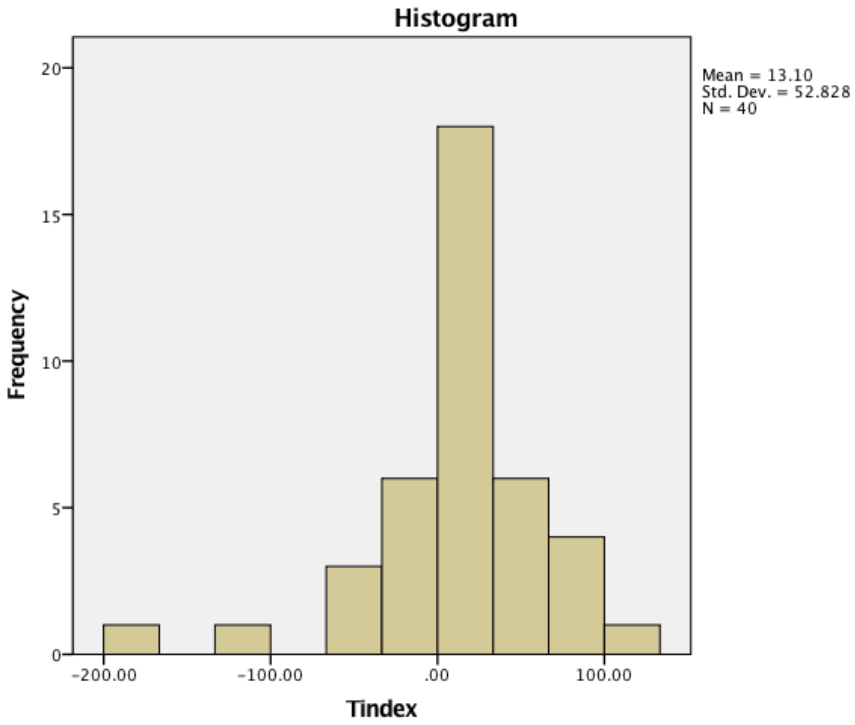

Figure 8: The difference of male skydivers' baseline salivary T concentrations and their T concentrations 15 minutes after completing a skydive. A positive 50 pg/mL value, for example, indicates a 50pg/mL post jump increase in salivary T concentration.

Furthermore, to test for a habituation effect, six participants provided an additional saliva sample after they completed a second jump. We used a t-test to compare the mean concentrations of salivary T because the sample size is really small (n=6). This round of samples showed that participants' T level after the second jump have a mean of 141.45 pg/mL (SD=102.46), which is significant lower ($p < .001$, one tailed, repeated measure) than their response following the first skydive (Mean=173.95 pg/mL; SD=107.92), therefore suggesting that there is indeed a habituation effect (see Figure 9). In addition, it is worth mentioning that participants' T concentration after the second jump was slightly lower than their baseline T concentrations indicating that a second jump has no effect on T.

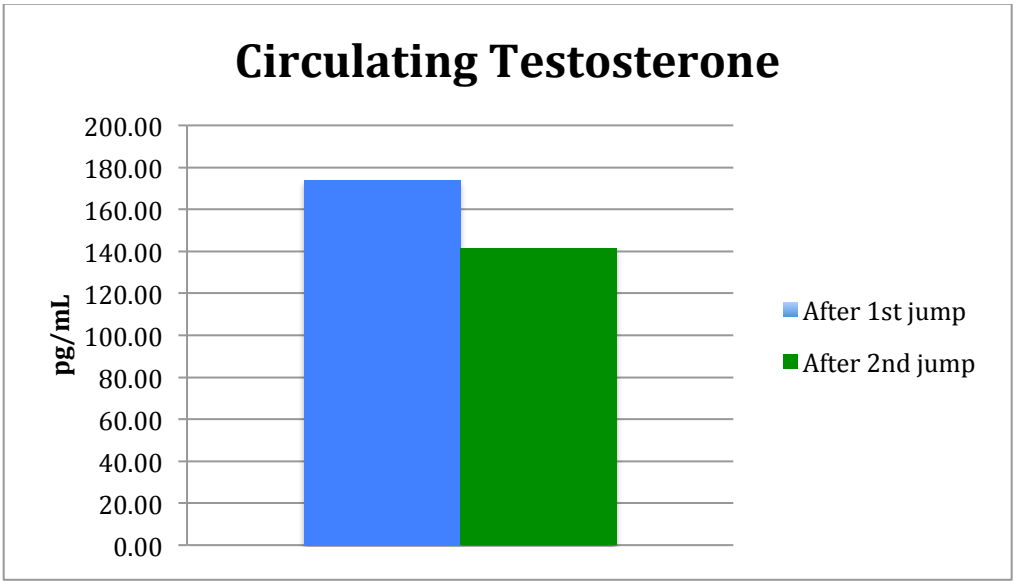

Figure 9: Skydivers' salivary T concentrations taken 15 minutes after their first and second jumps of the day. The T concentration decrease following the 2nd jump supports the notion of a habituation effect in hormonal response to repeated physical risk-taking.

Having established the presence of a significant response in circulating testosterone to extreme sports, we now turn our attention to morphological markers of testosterone as indicators of physical risk-taking proclivity.

Morphological Features (2D:4D and fWHR)

Hands scans were collected from 41 skydivers (12 females) and 92 controls participants (30 females). Their 2D:4D ratios were determined by dividing the length of their index fingers by the length of their ring finger. One-tailed t-test were conducted for both sexes to compare skydivers' 2D:4D ratios to those of control participants on both hands. The tests reject the hypothesis that extreme sport male athletes have a significantly

lower 2D:4D compared to control males in the case of both the left and the right hand. Nevertheless, female extreme sport athletes have a more masculinized digit ratio compared to control females on the left hand (p=.032) but not on the right hand, thus offering partial support for H2 (see Table 4).

Table 4: Skydivers' 2D:4D finger ratios compared to those of control participants**.**

	Males						p-value (1-tailed t-test)
	Skydivers			Control Athletes			
	N	**Mean**	**SD**	**N**	**Mean**	**SD**	
Left	29	0.96	0.02	62	0.95	0.04	-0.293
Right	28	0.97	0.03	62	0.95	0.04	-0.028
	Females						
	Skydivers			Control Athletes			
	N	**Mean**	**SD**	**N**	**Mean**	**SD**	
Left	12	0.95	0.02	30	0.97	0.04	0.032*
Right	12	0.96	0.02	30	0.98	0.04	0.057

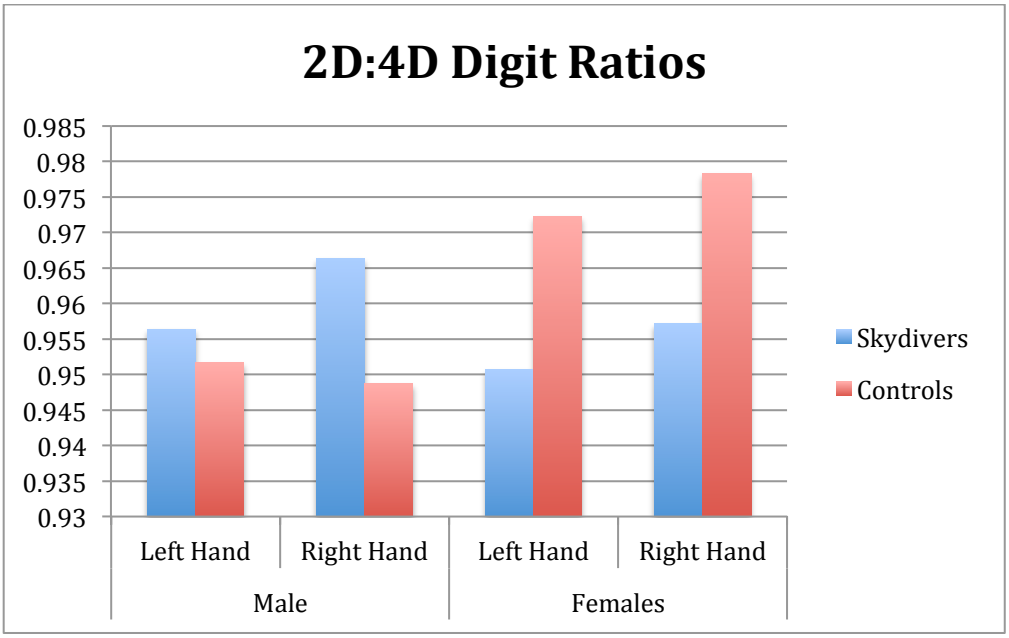

Figure 10: The second-to-fourth digit ratio is a marker of prenatal testosterone. A lower ratio is considered more androgenized.

Facial photographs were collected from 53 skydivers (12 females) and 84 controls (22 females). The fWHR was determined by dividing the width of the face by its height. A higher ratio is considered more androgenized. Contrary to our expectations, both male and female skydivers have a slightly smaller fWHR compared to male and female controls, respectively, therefore not comfirming H3. The average skydiving male and skydiving female fWHR is 1.73 (SD=.13) and 1.72 (SD=.10) respectively while that of control males and control females is 1.76 (SD=.10) and 1.74 (SD=.10) respectively. Two-tailed t-tests showed that male and skydivers are not significantly different from male and female control participants (see Table 5). Neither morphological marker of T within our sample is therefore sufficient to distinguish skydivers from non-extreme sports athletes. Next, the paper discusses the data collected through the administered questionnaire. We begin with the scales that are relevant to testing H4 and H5, namely the SOI and Mini-K.

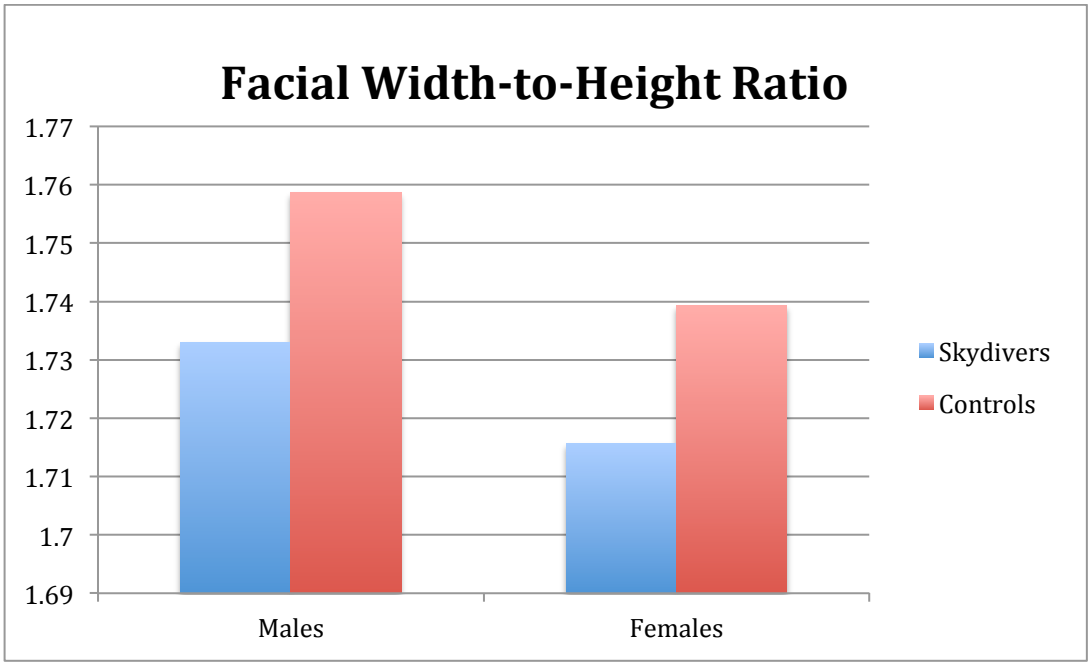

Figure 11: Facial width-to-height ratio is determined by dividing the width of the face by its length. A higher ratio is associated with greater developmental testosterone exposure.

Table 5: Skydivers' facial WHR compared to that of control participants.

	Males						p-value (2-tailed t-test)
	Skydivers			Control Athletes			
	N	**Mean**	**SD**	**N**	**Mean**	**SD**	
facial WHR	41	1.73	0.13	62	1.76	0.1	-0.133
	Females						
	Skydivers			Control Athletes			
	N	**Mean**	**SD**	**N**	**Mean**	**SD**	
facial WHR	12	1.72	0.1	22	1.74	0.1	-0.244

Sociosexual Orientation Inventory

Forty-seven skydivers (12 females) and 71 controls (27 females) completed the SOI scale. Table 6 displays the average scores of each group along with their standard deviations. One-tailed t-tests showed that skydiving males do not have a higher global score than control males, nor did they score significantly higher on any of the scale's facets (see Table 6). However, one-tailed t-tests demonstrated that skydiving females scored significantly higher than control females of the global SOI scale but not on any of its facets. This provides partial support for H4 (see Table 6). In addition, to test for a simple main effect of participants' sex or on each of the scale's facets we conducted a MANOVA (see Table 7) with the age of the participants as a covariate. Consistent with the previously conducted t-tests, engagement with skydiving does not predict any differences on the global SOI score or any of its facets. Although it is worth mentioning that females are more likely to vary on the global SOI score as a function of skydiving involvement compared to men (see Figure 13). The sex of the participant, on the other hand, exhibits a simple main effect on the global SOI score ($p<.05$) and on the *desire*

facet (p<.0001), with men scoring higher (see Table 7). There is no significant effect however from the interaction of one's sex and skydiving involvement.

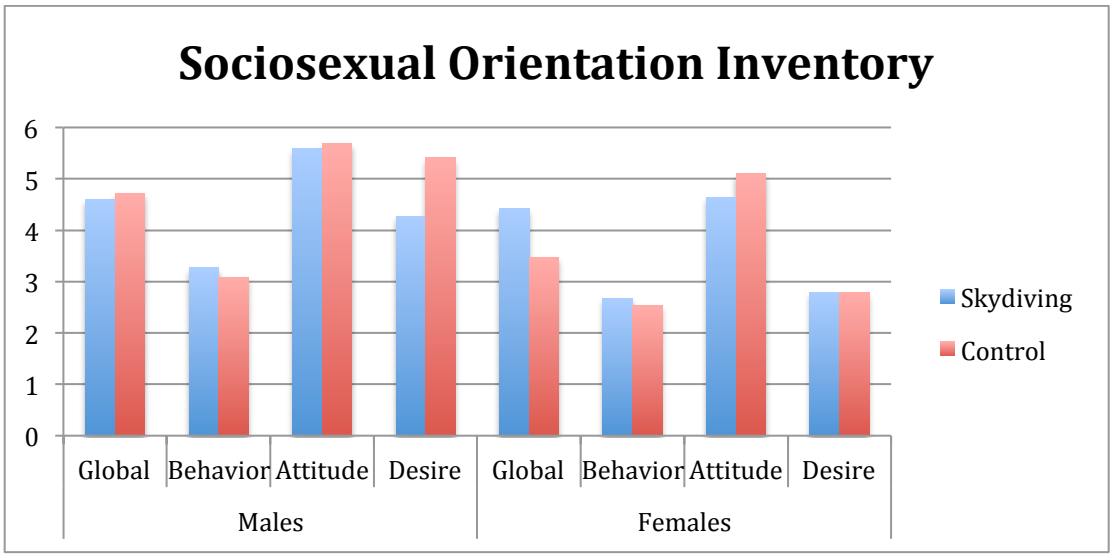

Figure 12 (above): Participants' scores of the Sociosexual Orientation Inventory. The scale has three facets (Behavior, Attitude and Desire) which compose a global score. Neither skydiving males or skydiving females have a higher global score than their non-extreme counterparts, nor do they score significantly higher than controls on any of the scale's facets.

Table 6: Skydivers' scores on the SOI scale and its facets compared to those of control participants.

	Males						p-value (2-tailed t-test)
	Skydivers			Control Athletes			
	N	**Mean**	**SD**	**N**	**Mean**	**SD**	
SOI Global	34	4.61	0.79	44	4.71	1.84	-0.384
SOI Behavior	34	3.26	1.71	44	3.08	2.21	0.347
SOI Attitude	35	5.59	2.13	44	5.69	2.38	-0.424
SOI Desire	35	4.28	2.17	43	5.41	2.1	-0.011
	Females						
	Skydivers			Control Athletes			
	N	**Mean**	**SD**	**N**	**Mean**	**SD**	
SOI Global	12	4.43	0.48	27	3.48	1.64	0.028*
SOI Behavior	12	2.67	1.46	27	2.53	1.67	0.405
SOI Attitude	12	4.64	1.59	27	5.1	2.7	-0.294
SOI Desire	12	2.79	1.38	27	2.78	1.44	0.489

Table 7 (below)**:** MANOVA: Test of between-subjects effects on the SOI scale and its facets.

Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	SOIGlobal	31.269[a]	4	7.817	3.674	.008
	SOIBehavior	9.680[b]	4	2.420	.669	.615
	SOIAttitude	26.310[c]	4	6.577	1.221	.306
	SOIDesire	154.320[d]	4	38.580	10.670	.000
Intercept	SOIGlobal	247.356	1	247.356	116.263	.000
	SOIBehavior	90.471	1	90.471	25.028	.000
	SOIAttitude	424.529	1	424.529	78.795	.000
	SOIDesire	253.853	1	253.853	70.206	.000
Age	SOIGlobal	2.512	1	2.512	1.181	.280
	SOIBehavior	.000	1	.000	.000	.994
	SOIAttitude	11.669	1	11.669	2.166	.144
	SOIDesire	12.099	1	12.099	3.346	.070
Sex	SOIGlobal	11.885	1	11.885	5.586	.020
	SOIBehavior	7.464	1	7.464	2.065	.154
	SOIAttitude	15.133	1	15.133	2.809	.097
	SOIDesire	103.335	1	103.335	28.578	.000
Skydiver	SOIGlobal	5.410	1	5.410	2.543	.114
	SOIBehavior	.593	1	.593	.164	.686
	SOIAttitude	.120	1	.120	.022	.882
	SOIDesire	2.667	1	2.667	.738	.392
Sex * Skydiver	SOIGlobal	4.880	1	4.880	2.294	.133
	SOIBehavior	.019	1	.019	.005	.943
	SOIAttitude	2.872	1	2.872	.533	.467
	SOIDesire	3.378	1	3.378	.934	.336

a. R Squared = .117 (Adjusted R Squared = .085)
b. R Squared = .024 (Adjusted R Squared = -.012)
c. R Squared = .042 (Adjusted R Squared = .008)
d. R Squared = .278 (Adjusted R Squared = .252)

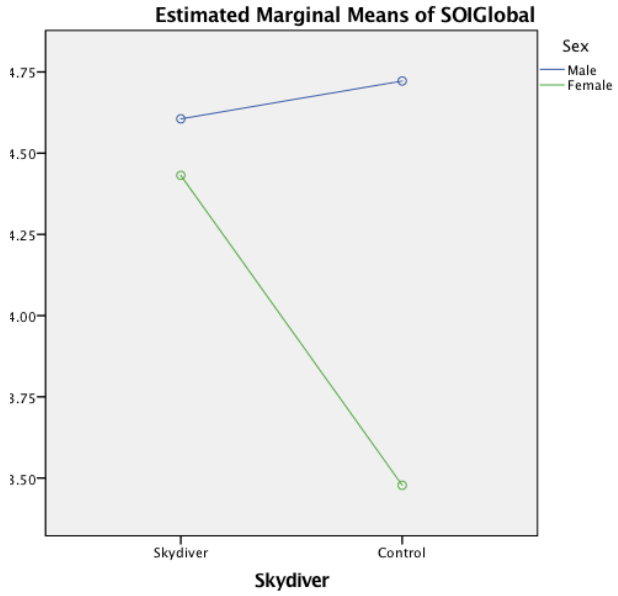

Figure 13 (left): Estimated marginal means of the global SOI scores.

Life History Theory

The Mini-K was completed by 45 skydivers (12 females) and 71 controls (27 females). To test H4, we conducted two t-tests to compare the scores of skydiving males to those of control males as well as the scores of skydiving females to those of control females. The average score of skydiving males is 0.68 (SD=.61) while the average score for control males is .99 (SD=.65). A one-way t-test supports H4 by demonstrating that the scores of skydiving men are significantly smaller than those of control males ($p<.05$) therefore indicating that Skydiving males are more likely to possess greater "low k" characteristics (see Table 8). In addition, we calculated the correlation between participants' age and their score on the Mini K scale in in both the male control and male skydiving groups. There is a statistically insignificant negative correlation between male participant age and their mini k scores in the control group($r=.116$; $p=.454$, two-tailed)

and an insignificant positive correlation in the experimental group (r=-.058; p=.747, two-tailed).

A one tailed t-test (p=-.242) however demonstrated that skydiving females (M=1.36; SD=.32) did not score lower than control females (M=1.25; SD=.54) (see Table 8).

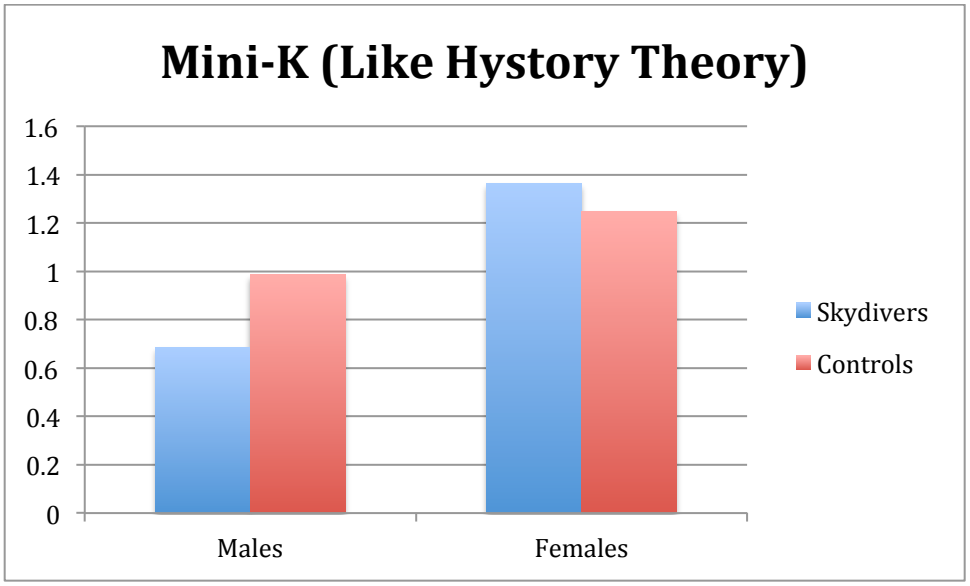

Figure 14: Participants' Mini-K scores. Skydiving males but not skydiving females have a significantly lower score than control males and control females respectively. This indicates that they possess greater "low k" characteristics.

Table 8: Skydivers' mini-k scores compared to those of control participants.

	Males						p-value (two-tailed t-test)
	Skydivers			Control Athletes			
	N	**Mean**	**SD**	**N**	**Mean**	**SD**	
Mini-K	33	0.68	0.61	44	0.99	0.65	0.022*
	Females						
	Skydivers			Control Athletes			
	N	**Mean**	**SD**	**N**	**Mean**	**SD**	
Mini-K	12	1.36	0.32	27	1.25	0.54	-0.242

In addition, we conducted a two-way ANAOVA with participants' age as a covariate to investigate simple main effects for participant sex, skydiving involvement and their interaction effect. Table 9 displays the ANOVA results which indicate that there is a simple main effect from the sex of the participant ($p<.001$), however, the ANOVA did not reveal any effect from participant involvement with skydiving nor did it show a statistically significant interaction between participant sex and skydiving involvement.

Table 9: Two-way ANOVA testing simple main effects of participants' sex and skydiving involvement on their mini-k scores.

Tests of Between-Subjects Effects

Dependent Variable: MiniK

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	6.555[a]	4	1.639	4.600	.002
Intercept	13.599	1	13.599	38.175	.000
Age_K	.040	1	.040	.113	.737
Sex	5.039	1	5.039	14.144	.000
Skydiver	.138	1	.138	.388	.535
Sex * Skydiver	.885	1	.885	2.483	.118
Error	38.830	109	.356		
Total	159.310	114			
Corrected Total	45.385	113			

a. R Squared = .144 (Adjusted R Squared = .113)

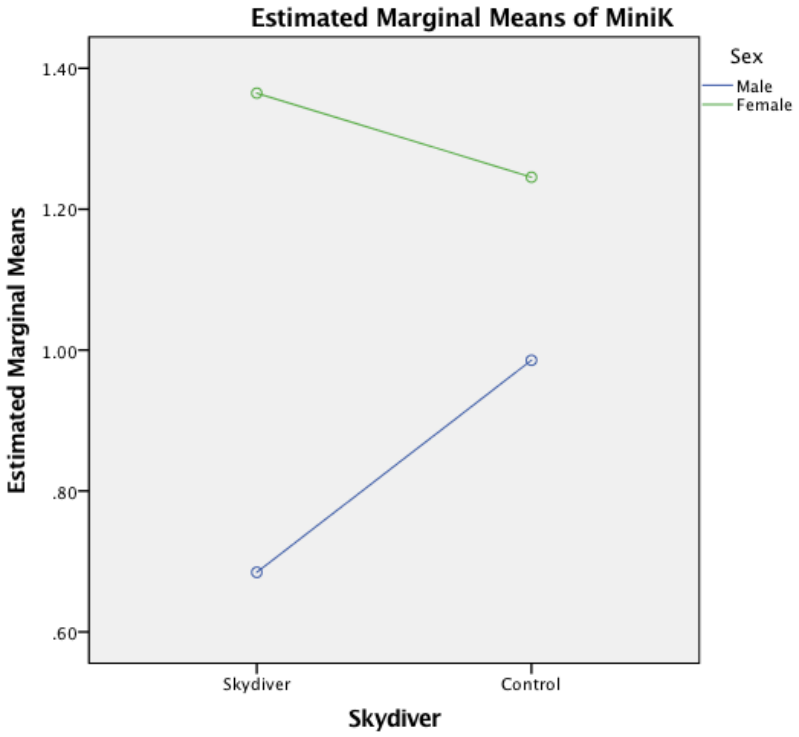

Figure 15: Estimated marginal means of participants' mini-k scores.

In addition to the scales relevant to our hypotheses, the questionnaire also included scales meant to explore additional potential differences between extreme and non-extreme sports athletes. The scales are the TIPI, the Grit Test and the SSS-V. We will now turn our attention to them.

The Big Five (TIPI scale)

The Big Five personality measures were collected from 46 skydivers (12 females) and 69 control participants (27 females). Participants' mean scores as well as their standard deviations are displayed in Table 10. Participants' individual scores passed *Levene*'s test of equality of error variances concluding that the error variance of the dependent variables is equal across groups. A two-way MANOVA revealed no simple main effect from skydiving involvement or from the interaction of participant sex and

skydiving involvement on any of the five personality traits (see Table 10). However, the same analysis revealed a simple main effect of sex on *agreeableness* (p=.05) and *conscientiousness* (p<.05) with females scoring higher than males.

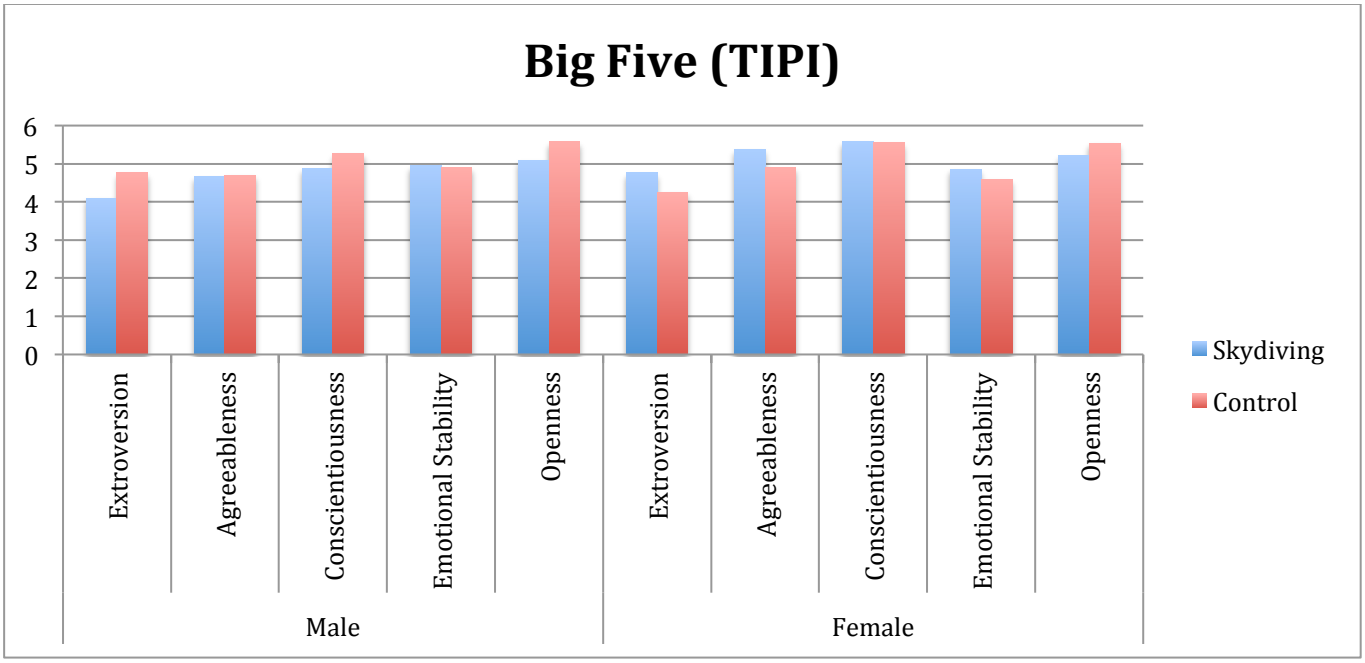

Figure 16: Participants' Big Five personality scores using the TIPI. The only significant simple main effect following a 2-way MANOVA stems from the sex of the participant which predicts that females will score higher on agreeableness and conscientiousness compared to males.

Table 10: Descriptive statistics of the experimental and control groups on the TIPI scale.

Descriptive Statistics

	Sex	Skydiver	Mean	Std. Deviation	N
Extroversion	Male	Skydiver	4.1706	1.54636	34
		Control	4.7619	1.46187	42
		Total	4.4974	1.51921	76
	Female	Skydiver	4.7583	1.48107	12
		Control	4.2444	1.64488	27
		Total	4.4026	1.59497	39
	Total	Skydiver	4.3239	1.53553	46
		Control	4.5594	1.54523	69

		Total	4.4652	1.53897	115
Agreeableness	Male	Skydiver	4.6529	1.05493	34
		Control	4.7024	1.11015	42
		Total	4.6803	1.07889	76
	Female	Skydiver	5.3750	.88330	12
		Control	4.8889	1.22736	27
		Total	5.0385	1.14377	39
	Total	Skydiver	4.8413	1.05337	46
		Control	4.7754	1.15216	69
		Total	4.8017	1.10945	115
Cons.	Male	Skydiver	4.8265	1.29435	34
		Control	5.2500	1.17000	42
		Total	5.0605	1.23710	76
	Female	Skydiver	5.5750	.89962	12
		Control	5.5556	1.41648	27
		Total	5.5615	1.26774	39
	Total	Skydiver	5.0217	1.23970	46
		Control	5.3696	1.27086	69
		Total	5.2304	1.26465	115
EmoStability	Male	Skydiver	4.9029	1.50423	34
		Control	4.9167	1.39650	42
		Total	4.9105	1.43588	76
	Female	Skydiver	4.8500	1.34806	12
		Control	4.5926	1.30116	27
		Total	4.6718	1.30343	39
	Total	Skydiver	4.8891	1.45055	46
		Control	4.7899	1.35962	69
		Total	4.8296	1.39126	115
Openness	Male	Skydiver	5.0676	1.14673	34
		Control	5.5952	1.03734	42
		Total	5.3592	1.11202	76
	Female	Skydiver	5.2250	1.40721	12
		Control	5.5370	1.16789	27
		Total	5.4410	1.23602	39
	Total	Skydiver	5.1087	1.20551	46
		Control	5.5725	1.08219	69
		Total	5.3870	1.15078	115

Table 11(below): MANOVA testing simple main effects of participants' sex and skydiving involvement on the Big Five personality traits.

Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	Extroversion	8.995[a]	3	2.998	1.275	.286	.033
	Agreeableness	5.316[b]	3	1.772	1.457	.230	.038
	Cons	9.843[c]	3	3.281	2.112	.103	.054
	EmoStability	2.023[d]	3	.674	.342	.795	.009
	Openness	6.212[e]	3	2.071	1.588	.196	.041
Intercept	Extroversion	1853.050	1	1853.050	788.062	.000	.877
	Agreeableness	2217.350	1	2217.350	1823.105	.000	.943
	Cons	2590.781	1	2590.781	1667.301	.000	.938
	EmoStability	2137.386	1	2137.386	1085.133	.000	.907
	Openness	2644.293	1	2644.293	2027.623	.000	.948
Sex	Extroversion	.028	1	.028	.012	.913	.000
	Agreeableness	4.755	1	4.755	3.910	.050*	.034
	Cons	6.401	1	6.401	4.119	.045*	.036
	EmoStability	.819	1	.819	.416	.520	.004
	Openness	.057	1	.057	.043	.835	.000
Skydiver	Extroversion	.035	1	.035	.015	.904	.000
	Agreeableness	1.098	1	1.098	.903	.344	.008
	Cons	.941	1	.941	.605	.438	.005
	EmoStability	.342	1	.342	.174	.678	.002
	Openness	4.061	1	4.061	3.114	.080	.027
Sex * Skydiver	Extroversion	7.037	1	7.037	2.992	.086	.026
	Agreeableness	1.652	1	1.652	1.358	.246	.012
	Cons	1.130	1	1.130	.727	.396	.007
	EmoStability	.423	1	.423	.215	.644	.002
	Openness	.268	1	.268	.205	.651	.002
Error	Extroversion	261.005	111	2.351			
	Agreeableness	135.004	111	1.216			
	Cons	172.480	111	1.554			
	EmoStability	218.637	111	1.970			
	Openness	144.759	111	1.304			
Total	Extroversion	2562.890	115				

	Agreeableness	2791.840	115				
	Cons	3328.430	115				
	EmoStability	2903.000	115				
	Openness	3488.190	115				
Corrected Total	Extroversion	270.001	114				
	Agreeableness	140.320	114				
	Cons	182.323	114				
	EmoStability	220.659	114				
	Openness	150.970	114				

a. R Squared = .033 (Adjusted R Squared = .007)
b. R Squared = .038 (Adjusted R Squared = .012)
c. R Squared = .054 (Adjusted R Squared = .028)
d. R Squared = .009 (Adjusted R Squared = -.018)
e. R Squared = .041 (Adjusted R Squared = .015)

The Grit Test

The skydiving group has a slightly higher score on the Grit Test compared to the control group for both sexes (see Table 12). Furthermore, skydiving females (Mean=3.73, SD=.43) and control females (Mean=3.44, SD=.73) have a slightly higher score than skydiving males (Mean=3.60, SD=.43) and control males (Mean=3.44, SD=.59) respectively (see Table 12). A two-way ANOVA, however, did not reveal any simple main effects or interaction from participant sex or skydiving involvement (se Table 13).

Figure 17: The skydiving group scored higher as a whole, however, a two-way ANOVA did not reveal any significant main effects from participant sex or skydiving involvement.

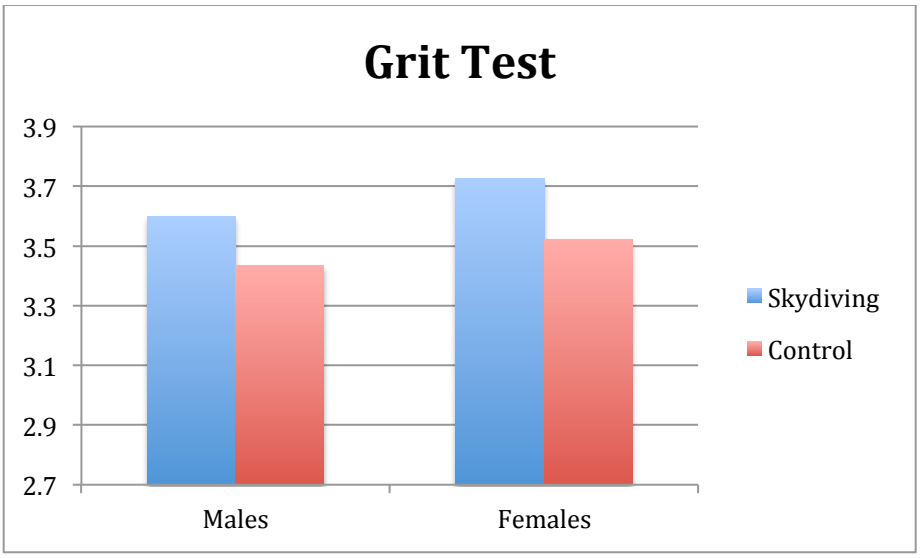

Table 12(below): The mean scores and standard deviation of the experimental and control groups on the Grit Test.

Descriptive Statistics

Dependent Variable: Grit

Sex	Skydiver	Mean	Std. Deviation	N
Male	Skydiver	3.5980	.42713	34
	Control	3.4360	.59480	43
	Total	3.5076	.53036	77
Female	Skydiver	3.7273	.42670	11
	Control	3.5224	.72670	26
	Total	3.5833	.65293	37
Total	Skydiver	3.6296	.42587	45
	Control	3.4686	.64377	69
	Total	3.5322	.57120	114

Table 13: Two-way ANOVA: testing simple main effects of participants' sex and skydiving involvement on the Grit Test.

Tests of Between-Subjects Effects

Dependent Variable: Grit

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	.966[a]	3	.322	.987	.402	.026
Intercept	1120.791	1	1120.791	3433.971	.000	.969
Sex	.255	1	.255	.783	.378	.007
Skydiver	.739	1	.739	2.265	.135	.020
Sex * Skydiver	.010	1	.010	.031	.861	.000
Error	35.902	110	.326			
Total	1459.153	114				
Corrected Total	36.868	113				

a. R Squared = .026 (Adjusted R Squared = .000)

The Sensation Seeking Scale form V

Participants' scores on the SSS-V are displayed in Table 14. Both male and female Skydivers scored higher than their non-extreme counterparts. A two-way ANOVA demonstrated that there is indeed a simple main effect from skydiving involvement ($p<.5$) but not from participant sex or the interaction of these two variables (see Table 15).

Table 14: The mean scores and standard deviation of the experimental and control groups on the SSSV.

Descriptive Statistics

Dependent Variable: SSSV

Sex	Skydiver	Mean	Std. Deviation	N
Male	Skydiver	24.1765	4.80827	34
	Control	22.2656	6.16962	32
	Total	23.2500	5.55133	66
Female	Skydiver	23.7727	5.64962	11
	Control	20.1750	6.78480	20
	Total	21.4516	6.54644	31
Total	Skydiver	24.0778	4.96231	45
	Control	21.4615	6.42975	52
	Total	22.6753	5.91346	97

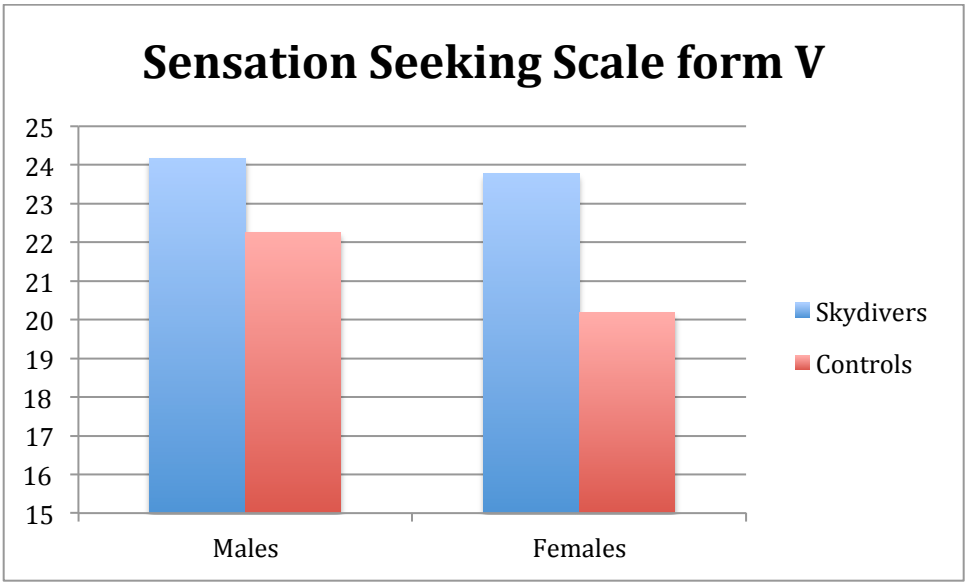

Figure 18: Skydivers score higher than the control group in terms of sensation seeking. A two-way ANOVA confirmed that skydiving involvement has a simple main effect on participants' SSS-V scores.

Table 15 (below): Two-way ANOVA: testing simple main effects of participants' sex and skydiving involvement on the SSSV.

Tests of Between-Subjects Effects

Dependent Variable: SSSV

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	220.268[a]	3	73.423	2.177	.096	.066
Intercept	40533.241	1	40533.241	1201.750	.000	.928
Sex	30.867	1	30.867	.915	.341	.010
Skydiver	150.539	1	150.539	4.463	.037	.046
Sex * Skydiver	14.117	1	14.117	.419	.519	.004
Error	3136.753	93	33.729			
Total	53231.250	97				
Corrected Total	3357.021	96				

a. R Squared = .066 (Adjusted R Squared = .035)

This concludes the results section. The paper will now discuss these results and interpret them with regard to the theoretical foundation of this study.

DISCUSSION

Circulating Testosterone

This section will discuss the posited hypothesis in order. As predicted, engaging in a risky physical activity prompted male participants' T levels to rise considerably (H1). In addition, the salivary assays collected from six participants subsequent to their second skydive demonstrated that there is a habituation effect in hormonal response. The significant increase in T post parachuting suggests that successfully engaging in a physical risk could trigger an endocrinological response in men that is similar to the one triggered during competition. Given that T is largely responsible for sexual dimorphism in humans and other animals, with men producing 9 to 10 times as much T as women (Torjesen, & Sandnes, 2004), these results suggest that T acts as a mediator for men's engagement in physical risk-taking. In other words, the discernibly high sex imbalance in extreme sports participation has a basis in biology. Throughout our evolutionary past, men were in a position where physical risk-taking could yield greater rewards compared to females. Women, on the other hand, were simply not evolutionarily pressured to take risks to the extent that men were. This sex difference is consistent with evolutionary theory and its sub-theories, namely, the Parental Investment Theory and costly signaling. Parental Investment Theory highlights the reality that women have a much greater minimal investment than men do to successfully reproduce. As a result, women are also generally choosier when selecting potential mates (Saad, Eba, & Sejean, 2009). Men, on the other hand, are generally more likely to compete for mates by signaling their mating fitness. To successfully portray their value as mates, men engage in honest signaling by displaying their ability to gain resources or, in the case of this study, by taking on

recreational physical risk-taking. Men's engagement in physical risk-taking, such as skydiving, displays their courage, strength, fitness, coordination and athleticism. These traits are deemed desirable by women and influence their choices of mate selection.

Morphological Markers of Testosterone

Next, we turn to the second and third hypotheses. In addition to salivary assays, morphological measurements were taken under the form of 2D:4D digit ratios and fWHR. A low 2D:4D digit ratio as well as a high fWHR are associated with higher T exposure during development. Contrary to expectations, when compared to same sex individuals, male skydivers do not have more masculinized digit ratios compared to the non-extreme sports control group (H2), however, skydiving females did have more androgenized 2D:4D but only on the left hand. Nevertheless, this represents only minimal support for H2 considering that previous literature suggests that the digit ratios of the right hand tend to be more sexually differentiated than digit ratios of the left hand (Manning et al., 2007; Voracek et al., 2010). Skydivers' fWHR are not more androgenized compared to those of the same sex control group (H3). These results may suggest that extreme sports athletes are not necessarily exposed to higher levels of T during development. An equally likely explanation, however, is that in the case of both the 2D:4D ratios and the fWHR, our sample size is insufficient to detect this difference. Studies that focus primarily on digit ratios, for example, generally report significantly larger samples (Voracek, 2009; Bailey & Hurd, 2005; Nepomuceno et al., 2016, Manning et al., 1998), as digit ratio effects are unlikely to be detected in relatively smaller samples. Similarly, an effect may be unlikely to be detected in an ethnically heterogeneous sample (Stenstrom et al., 2011; Apicella et al, 2008; Manning, Churchill & Peters, 2007).

Although roughly 94% of males in the experimental group are Caucasians, the male control group is comprised of roughly 39% Caucasians, 23% Asians, 10% Middle Easterners, 7% Blacks/Africans, Hispanics or other. Given its high degree of ethnical diversity, the control group is therefore not an ideal group to compare digit ratios.

Sociosexual Orientation Inventory

Moving on to the fourth hypothesis, skydiving males did not scored significantly higher on the SOI scale, or on any of its facets, compared to control males. Contrary to expectations, the males from the control group scored higher on the desire facet compared to skydiving males. Given that libido decreases with age (Kontula & Haavio-Mannila, 2009), this unexpected finding may be due to the age discrepancy between the groups. Indeed, the age of the average control male is 24.2 years (SD = 6.9 years) while the average age of the male skydivers in our sample is 32.3 years (SD = 10.5). In addition, 60% of the male skydivers in our sample are in a long-term relationship with an average duration at the completion of the survey of 6.3 years while only 31% of the males in the control group are in long-term relationships with the average duration of 2.1 years. This is expected as individuals are more likely to be in lasting relationship later in life and sexual appetite decreases as the duration of relationships rises. “Even if sociosexuality does possess stable, traitlike qualities, its phenotypic manifestations may change over the life span. During the dating years, for instance, individual differences in sociosexuality might be more clearly revealed in differential willingness to engage in sex prior to the development of commitment and strong emotional ties.” (Simpson & Gangestad, 1991, p.879). Therefore, the failure to detect the expected mean difference in men’s average SOI scores may be due to 8.3 years of mean age difference between the

experimental and control groups, as well as by the fact that the sample of skydivers sample are more likely to be in long-term relationships.

Skydiving females, on the other hand did have globally higher scores on the SOI scaled compared to control females. Interestingly, the global SOI scores vary greater as a function of skydiving involvement for female participants compared to male participants, with skydiving women scoring higher than their same sex controls. It is worth mentioning that, as predicted by Triver's Parental Investment Theory (1972) and consistent with previous works (Penke & Asendorpf, 2008), men, regardless of skydiving involvement, scored higher on the global SOI global score compared to women. Men also scored especially high on the desire facet compared to women, which outlines men's higher penchant for casual, uncommitted sexual relationships.

Life History Theory

Next, we discuss the fifth and final hypothesis. Males' scores support H5 by demonstrating that skydiving males possess greater "low K" characteristics compared to control males. This suggests that male extreme sport athletes may allocate a greater portion of their resources toward reproductive efforts compared to their non-extreme counterparts. "Low-K" characteristics may take the form of impulsivity, short-term thinking, promiscuity, low or no parental investment, little social support, disregard for social rules and extensive risk-taking. Skydiving females, on the other hand, did not score significantly different on the Mini-K scale compared to non-skydiving females, suggesting that the relationship between Life History Theory and extreme sports may only apply to males. In addition, when comparing the sexes, regardless of extreme sport participation, the results showed that males are much more likely to live a "low-K"

lifestyle. This finding is consistent with Trivers' Parental Investment Theory in the sense that given the suitable environment, men are able to adopt a promiscuous mating strategy which can result in a greater number of offspring with low parental investment. Females, on the other hand, are biologically compelled to greater parental investment due to gestation. Therefore, the potential benefit of adopting a "low-K" is less likely to benefit women in an evolutionary sense. The next section will discuss the additional scales included in the questionnaire that are not related to the study's posited hypotheses.

The Big Five (TIPI scale)

To begin with, we did not detect any significant simple main effect from skydiving involvement on any of the Big Five personality traits. However, participant sex has a simple main effect on *agreeableness* and conscientiousness with females scoring higher across the groups. This sex difference in personality has previously been shown (Schmitt, Realo, Voracek, & Allik, 2008) regardless of extreme sport participation, However, a possible explanation for it in the context of parachuting is that skydiving clubs may create an environment of implied competition among males, thus priming male participants to be less agreeable, whereas females would be less likely to experience this sense of rivalry. It is important to note, however, that the TIPI scale is ideally used when researchers have a time constraint and when the main focus of the study is not personality given that the scale is a shortened, less reliable, version of the original Big Five personality scale (Gosling et al., 2003).

The Grit Test

Both males and females form the skydiving group scored higher than male and female controls on the Grit Test. A two-way ANOVA however, did not yield any

significant main effect from the sex of the participant of their involvement with skydiving. One possible explanation for this is that individuals who regularly engage in physical activity might have more grit than their non-physically active counterparts but not significantly less than skydivers. In other words, grit may not be an important factor in distinguishing between extreme and non-extreme sports participants as long as these athletes are disciplined in their training.

The Sensation Seeking Scale form V

Skydivers, regardless of sex, scored higher than controls on sensation seeking. While the difference in the scores of males and females in the skydiving group is minute, the difference in scores is somewhat more pronounced in the control group with males scoring higher albeit not statistically significant. A two-way ANOVA revealed a simple main effect form skydiving involvement but not from the sex of the participant or from the interaction between the two variables. This significant simple main effect is consistent with previous studies linking extreme sport athletes with a high sensation-seeking trait (Zuckerman, 1983; Murray, 2003). The particularly interesting finding is that despite previous studies having established age and sex differences in sensation seeking (Steinberg, Albert, Cauffman, Banich, Graham, & Woolard, 2008) with young males being the greatest sensation seekers (Wilson & Daily, 1985), skydiving females challenge the status quo by scoring higher than control males. Not only so, but they score higher despite being on average 3.6 years older.

Table 16 summarizes the posited hypothesis and the results associated with each. Next, we turn our attention to the shortcomings of this study and its practical and theoretical applications.

Table 16: Hypotheses and results

Hypothesis	Support	Statistic
H1: Male skydivers experience a temporary increase in circulating testosterone compared to their baseline testosterone levels after performing a successful jump.	Supported	One-tailed t-test p=.007**
H2: Both male and female extreme sports athletes have more masculinized digit ratios compared to their non-extreme sports counterparts.	Minimally Supported	One-tailed t-test p=.032*
H3: Both male and female extreme sports athletes have a higher facial width to height ratio compared to their non-extreme sports counterparts.	Not Supported	One-tailed t-test p=-.133 (males) p=-.244(females)
H4: Both male and female extreme sports athletes score higher on the SOI scale compared to their non-extreme sports counterparts.	Partially Supported	One-tailed t-test p=-.384 (males) p=.028*(females)
H5: Both male and female extreme sports athletes will scores lower on the mini-k scale compared to their non-extreme sports counterparts.	Partially Supported	One-tailed t-test p=.022* (males) p=-.242(females)

LIMITATIONS AND FUTURE RESEARCH

The study has four sample-related limitations. It is possible that we simply did not have a large enough sample to capture some of the expected effects. This issue is especially true in the case of the female skydiving group, which was comprised of only 12 participants. Several of our results related to male skydivers did not reach statistical significance but turned out to be consistent with our expectations in a directional sense. A larger experimental group would have allowed for more robust statistical results. For future studies, we recommend a more strategic and efficient way of seeking participants. Given that the nature of the study required in-field work, we had to individually approach every participating skydiver and solicit their cooperation. There were multiple distractions and a constant sense of urgency due to the scheduled plane departures and the

"high-energy" nature of the skydiving club. This decreased skydivers' participation rate, which in turn reduced our goal sample size of 100 by approximately half. In addition, we overestimated the number of skydivers that frequent the skydiving club. For an improved data collection process, we recommend that future researchers attempt to collect data from multiple skydiving clubs as opposed to only one, that they focus on creating a better symbiosis with the skydiving club in order to facilitate the interaction with the participants, and finally, to preemptively inform potential participants that a study will take place before collecting the data in the hopes of sparking their curiosity and cooperation.

The second limitation stems from the fact that we had unbalanced samples for each of the experimental and control groups. The cell sizes of the experiment for males and females as well as for skydivers and control participants are rather different. The F-test associated with the study's ANOVAS is therefore not robust due to violations of normality and equal variance across the cells.

The third limitation related to our sampling is due to a much younger male control group. The age gap of 8.12 years may be the root of several external variables that were not controlled for when comparing the skydiving and the control male samples on the study's variables of interest. To begin with, our sample of skydivers were more likely to be in long-term romantic relationships and their relationships are more likely to be of longer duration compared to those of control males. These variables may influence their scores on the different scales of our questionnaire, in particular the SOI scale and the mini-k scale. In addition, skydivers are more likely to have a higher socio-economic status by virtue of their age. Not only that, but skydiving is an expensive sport, thus

placing skydivers even higher on the socio-economic status scale. Lastly, another issue stemming from the age discrepancy between the experimental and control male groups is that males from the control group, which is mostly comprised of young university students, may possess the biological and/or psychological profile associated with extreme sports athletes. Although the researcher was careful in selecting only control participants who do not regularly engage in extreme sports, there may be several athletic and vigorous young men who do not participate in extreme sports simply because they did not yet have the chance of discovering them or because they cannot afford them. Future studies should prevent this age gap and the potential issues associated with it by choosing a gym or a sports center outside a university to recruit older participants acting as controls for skydivers.

Lastly, the control group is comprised of individuals with diverse ethnic backgrounds, which is not ideal for comparing morphological features. Indeed, past research has demonstrated that a low 2D:4D finger ratio is associated with risk raking only in ethnically homogeneous samples (Stenstrom et al., 2011, Apicella et al, 2008; Manning, Churchill & Peters, 2007). In other words, 2D:4D effects are much less likely to exist when the control and the experimental groups are of different ethnicities. These findings should be kept in mind for any future research that focuses primarily on finger ratios.

In addition to addressing the shortcomings of this study, future research can attempt to replicate our results by investigating the relationship between circulating testosterone and physical risk-taking across a broad range of extreme sports and other status signaling behaviors. Furthermore, it would be interesting to determine a) how long

after the status achieving behavior do the subjects experience the peak of circulating T, b) what is the duration of this peak in circulating T and c) why do these timings vary among different status achieving behaviors?

To continue, researchers can investigate how testosterone levels affects men's decision making. For example, Saad and Vongas (2009) demonstrated that men who engaged in conspicuous consumption, namely driving a luxurious sport car, experienced an increase in circulating testosterone. Given that status products are a means by which men can elevate their perceived status, could T acts not only as a successor but also as a precursor of conspicuous consumption? This is quite possible considering that several studies (Mazur 1985, 2005; Archer, 2006) revealed a bidirectional relationship between elevated levels of testosterone and status seeking behavior in men. For example, it is easy to imagine that when in the presence of nubile women, men are more likely to spend money on products or services that will allow them to display high status (e.g. an expensive watch or access to the V.I.P. area of a venue). In these cases, the purchases are made as a mean of signaling high status. Does the same status-related consumption exists not only as a means to display, but also as a consequence of having gained high status? In other words, are men more likely to purchase luxury items or fancy services shortly after a status achievement than at any other time? The logic here is that conspicuous consumption can act as a vehicle for men to elevate their perceived status following an event that increased their level of T. This possibility is consistent with the aforementioned bidirectional relationship between T and status seeking behavior. In addition, would men's more pronounced interest in status products following a status elevation correspond to the duration of increased circulating testosterone? In other words,

it can be hypothesized that following a man's status achievement, his T concentration increases and results in an increased likelihood of conspicuous consumption. For example, if Mr. Smith receives an award in his field of work that results in an increase in circulating testosterone lasting 24h, will there be a corresponding temporal increase in the likelihood that Mr. Smith will purchase a status product?

Finally, our study highlighted the uniqueness of female skydivers in that these individuals scored similarly to men on the SOI scale. By engaging in physical risk-taking, female skydivers, challenge the notion that women do not have a drive to engage in physical risk-taking. Nevertheless, given their low numbers across different extreme sports, they are the exception to the rule when it comes to explaining physical risk-taking from a Darwinian standpoint. Men do not value a penchant for risk-taking, athleticism or courage when assessing a potential mate to the extent that women do. This makes women's engagement in extreme sports a puzzling behavior. There are multiple factors that may come into play to account for this behavior. An individual's likelihood to engage in a particular extreme sport must be, at least in part, fostered by environmental factors. Therefore, one explanation for these women's behavior is that they experienced a particular environment in their development and/or adult lives that fostered a penchant for risk-taking which led them to adopt skydiving regardless of their biological makeup. For example, Sulloway (1996) proposed that birth order could, to a certain extent, predict an individual's likelihood of being daring, untraditional and rebellious; traits which are unanimous with extreme sports engagement. More precisely, Sulloway proposed that as a consequence of sibling competition for parental investment, newborns seek to occupy a certain niche within the family as they develop. Firstborns tend to occupy a "safe" niche

by adopting a conforming and obedient role for their parents. Laterborns, in turn, are more likely to be rebellious and to challenge the status quo in an attempt to reverse parent's favoritism towards the eldest child (Zweigenhaft & Von Ammon, 2000; Sulloway, 2001; Rohde, Atzwanger, Butovskaya, Lampert, Mysterud, Sanchez-Andres, & Sulloway, 2003) In this study, half of the skydiving females have at least one older sibling whereas only 30% of the control females have at least one older siblings. Skydiving women could have therefore been in part influenced by their birth order to take up an unconventional recreational activity such as parachuting. An alternative explanation is that these women are located on the higher end of the spectrum of androgenized traits, for example a relatively high score on the SOI scale and a penchant for physical risk-taking, as our study shows. A way to test this possibility is to compare a large, ethnically homogeneous sample of female extreme sports practitioners with a control group on characteristics that are associated with androgenic hormones such as the 2D:4D finger ratio, the Baron-Cohen, Wheelwright, Hill, Raste, and Plumb (2001) social sensitivity test, Vandenberg Mental Rotation task (V-MRT) (Vandenberg & Kuse, 1978) or circulating T. Next we turn our attention to the theoretical and practical contributions of this research.

THEORETICAL AND PRACTICAL CONTRIBUTIONS

This study offers an elegant Darwinian explanation for a seemingly unnatural and irrational behavior. Theoretically, it contributes to evolutionary psychology's tree of nomological validity by joining principles of the relevant evolutionary sub-theories to obtain a fuller account of a consumption-related behavior. Metaphorically, Darwinian

theory acts like an orchestra conductor, combining a variety of available instruments (sub theories and/or proximate explanations) to create a rich and harmonious symphony (understanding of a certain phenomenon). Evolutionary psychology provides a theoretical foundation that is domain specific and that allows for the creation of precise and testable hypothesis, which outside of evolutionary theory are difficult to posit. It would be far more challenging, if not impossible, to offer an account for extreme sport consumption from a rational, classical economist perspective given that there is no apparent utilitarian benefit from spending thousands of dollars to jump out of planes. This paper strengthens the notion that behavior should be examined from the lens of ecological rationality. Gigerenzer and Todd (1999) first introduced this concept by proposing that individuals' seemingly irrational behavior is actually rational when considering that their decisions are often based on heuristics. These heuristics generally lead to positive outcomes when the observer takes into account the decision's specific domain of relevance. A normatively rational approach, on the other hand, does not offer the adequate theoretical background to tackle seemingly irrational behavior.

A similarly feeble theoretically approach is the widely adopted Standard Social Science Model (SSSM), which views behavior as a consequence of proximate socialization processes and environmental factors while often dismissing the ultimate evolutionary explanations. Although it is widely agreed that almost all human behavior is a consequence of both environmental and biological origins, the SSSM does not have the same explanatory power as evolutionary psychology, nor does it have as rich of a theoretical foundation to make the kind of specific and consilient predictions that evolutionary psychology allows researchers to do (Saad, 2006, 2016; Wilson, 1999). The

authors of this study are curious to know how the SSSM can account for universal sex imbalances in risk-taking. It would be farcical to propose, for example, that a hormonal response (surge of testosterone) to an activity (skydiving) is the result of socialization forces. Both the SSSM as well as the classic economist approach offer, at best, an incomplete explanation for human behavior.

Evolutionary psychology, on the other hand, allows the researchers in this study to understand men's drive to engage in activities that are puzzling from a utilitarian perspective by explaining this behavior's adaptive function using middle-level evolutionary theories, namely Sexual Selection, Parental Investment and Costly Signaling. It also sheds light on the outrageously imbalanced sex ratio in extreme sports by arguing that women are intrinsically less inclined to take physical risks. This study also reveals a physiological response to physical risk-taking by demonstrating that circulating T levels increase in men after performing a skydive. This endocrinological response is similar to the one triggered during competition and is associated with dominance and high status (Archer, 2006, Mazur, 2005). This paper therefore supports the notion that men engage in extreme sports as a means to gain status and signal their mating fitness. Furthermore, given that T is the main hormone responsible for our species sexual dimorphism and considering the exceptionally high sex ratio in extreme sports, it can be argued that T functions as a mediator for physical risk-taking. This hypothesis is consistent with Mazur's (1985, 2005) biosocial model of social status, which states that increases in T elicit status-seeking behaviors. In turn, the social status increase prompts an elevation in T levels. This model was demonstrated in the case of male dominance and

could very well apply to physical risk-taking when considering that this is also a form of status-seeking behavior.

Focusing on the endocrinological response to extreme sport consumption, the present work provides a fuller understanding of a consumer behavior (engaging in extreme sports) by observing the biological underpinning associated with it. This study, along with a growing trend of similar works investigating consumption at the hormonal level (Aspara & Van Den Bergh, 2014; Durante, Griskevicius, Perilloux, & Li, 2011; Lens, Driesmans, Pandelaere, & Janssens, 2012; Saad & Stenstrom, 2012; Saad & Vongas, 2009) is making it increasingly more difficult to ignore the importance of biological forces in consumer research.

Regarding practical contributions, there are countless ways by which marketing practitioners can apply this framework in understanding the consumption of extreme sports. Considering that men's willingness to take risks is deemed attractive by women and given that men often jump on the opportunity to display their dominance and mating fitness through their willingness to take risks, marketers could make good use of an endorser that built his/her reputation through the practice of an extreme sport. This strategy can be used in industries where risk is ubiquitous. For example, a private investment company could look into the growing sport of highlining for an advertisement campaign (see Figure 19). By hiring a member form the highlining community to be their endorser, ideally someone who build his/her reputation with outstanding skill, creativity or community involvement, a private investment group can redefine the way its current and potential clients interpret risk. This can be done by drawing a parallel between investing in a private investor's group and highlining. Even if both activities may appear

"crazy" to a varying degree, one could argue that practitioners from both domains are in ample control to perform their respective tasks. Consequently, the potential terrifying outcomes can be overshadowed by the potential rewards of achieving one's objectives.

Figure 19: Example of a potential advertisement concept incorporating physical risk-taking.

Image source:
https://www.flickr.com/photos/jeffpang/15554008495/in/photostream/
Photographer: Jeff Pang
This image was not modified from its original source

Given that men's penchant for extreme sports is ultimately rooted in their motivation to assert their masculinity and to display their mating fitness, marketers can piggyback on this phenomenon by facilitating or providing clever ways in which men can display the traits that women generally value in a mate. Consumers often relate to brands like they would to real individuals by attributing human personality traits to the brands in question (Fournier, 1998). Consumers also perceive brands as extension of themselves,

which they then use as vehicles of self-expression along several personality dimensions (Aaker, 1997). It is therefore in the best interest of marketing practitioners to shape their brand personality in accordance with the cumulative personality of their target market. Physical risk-taking can act as a tool for marketing practitioners to shape brands on certain personality dimensions. For example, ruggedness, which is one of the five dimensions of brand personality revealed by Aaker (1997), is composed of traits like outdoorsy-ness, toughness and strength. Similarly, Grohmann (2009) developed a two dimensional scale to measure masculinity and femininity as personality traits that brands can incorporate. The masculinity dimension is composed of the following factors: adventurous, aggressive, brave, daring, dominant and sturdy. It is easy to imagine how extreme sports can helps shape consumer perception of brands considering that outdoorsy-ness, toughness and strength (rugged personality dimension) and adventurous, brave, daring and dominant (masculinity personality dimension) represent traits that are synonymous with most extreme sports.

Furthermore, marketers can promote the consumption of goods and services associated with traits that men wish to flaunt by encouraging the presence of women as audience members. This is especially the case for consumers with pronounced "low-K" characteristics whose lifestyles, in respect to Life History Theory, are centered on reproductive efforts. A stereotypical scenario displaying this phenomenon is a wealthy gambler surrounded by attractive women at a casino's roulette table. One has to wonder if the gambler would be as willing to take the same risks absent the female audience. Similarly, rock-climbing gyms, for example, can strategize to increase the number of female members with the help of discounts and promotions. It is easy to imagine how a

larger number of female climbers would significantly increase the number of male memberships and, most likely, their satisfaction of the rock-climbing gym experience in general.

To continue, several studies revealed a link between T and the performance of male financial traders. Coates and Herbert (2007) for example, showed that traders' morning T levels predicts their profitability for rest of the day, suggesting that high T contributes to financial returns. Similarly, Apicella et al. (2014) demonstrated that financial traders' T levels influence financial risk-taking, while another study (Coates, Gurnell, & Rustichini, 2008) showed that the second-to fourth digit ratio (a biomarker of T) predicts success among high frequency financial traders. These studies, along with the work presented in this paper, suggest that men could benefit from engaging in extreme sports by capitalizing on the resulting endocrinological response in their field of work. In other words, someone who recently jumped out of a plane or rock-climbed Yosemite's El Cap is arguably less likely to be intimidated when faced with other forms of risk. This is not only applicable to financial trading but to any other financial interactions or marketing domains with an endocrinological footprint. Examples include car salesmen, real estate agents, telemarketers or any primarily male profession involving a certain degree of risk, dominance or aggressive negotiations.

Moreover, given that T levels increase as a consequence to skydiving, extreme sports could be incorporated into treatment programs that deal with issues related to low T, such as depression. Several studies linked depression with low T levels in men, especially so in the older population (Booth, Johnson, & Granger, 1999b; Seidman, & Walsh, 2000; Amiaz & Seidman, 2008). A meta-analysis (Zarrouf, Artz, Griffith, Sirbu,

& Kommor, 2009) concluded that T has antidepressant effects in depressed patients, especially those suffering from hyogonadism, HIV/AIDS and elderly populations. Perhaps the adoption of an extreme sport can be used in tandem with conventional treatments of depression by naturally increasing patient's T levels.

Finally, this study offers a framework that can be used to tackle societal issues related to the aforementioned "young male syndrome". Wilson and Daily (1985) examined young males' proclivity for competitiveness, risk, violence and other antisocial behaviors through the lens of evolutionary biology. They argued that these behaviors are driven by male intrasexual competition (competition between members of the same sex over a potential mate). Wilson and Daily's (1985) work investigated homicides in Detroit and showed that the profiles of the victim and the offender are almost identical. Young, unemployed, unmarried men are greatly overrepresented in homicide incidents and in many, if not most cases, these homicides are concerned with status competition. The authors also investigated risk-taking in the form of gambling and daredevilry and concluded that these are primarily male activities, which are facilitated by the presence of peers in pursuit of the same goals. Similarly, additional studies demonstrated that young male drivers are the most likely to engage in dangerous driving (Ulleberg, 2001; Constantinou, Panayiotou, Konstantinou, Loutsiou-Ladd, & Kapardis, 2011) and to be, across cultures, the victims of pathological gambling (Gray, 2004). This study offers a theoretical foundation that reveals the driving force of these unhealthy behaviors. Namely, it entails that the majority of status competition, homicides, dangerous driving or pathological gambling ultimately originate from the struggle that young men undergo in an attempt to achieve social status and gain access to mating opportunities. Three

decades ago, Jonah (1986) hypothesized that adolescents' risky driving is rooted in their need to express their manhood, their fearlessness, their competence and their independence. Is it also a way for them to defy authority, to impress their peers and to experience a sense of adventure. Through what better way could a teenager achieve this if not through the practice of an extreme sport? Rock-climbing, for example, is a highly independent, self-reliant, unconventional sport that requires significant mental fortitude and competence. The participant can regularly display their fearlessness and assert their abilities given the sport's clear objectives and wide spectrum of difficulty. The thrill of driving over the speed limit or of other delinquent behaviors pales in comparison to the adventure associated with outdoor rock-climbing. If violence, pathological gambling and dangerous driving are vehicles through which frustrated young men attempt to assert their manhood, impress their peers and display their dominance, then extreme sports, including combat sports, offer a much healthier and rewarding means to achieve the same goals. These insights can easily be incorporated into public service announcements and should prove useful to parents, teachers and other socializing agents alike.

Overall, this paper demonstrates both the practical and theoretical applicability of a Darwinian approach to investigate consumer phenomena. It is only by accepting that consumers are subject to innate drives that the field of marketing research can advance towards a fuller understanding of consumer behavior. Once we acknowledge our biological underpinnings, we can appreciate the rich explanatory power of evolutionary psychology of why we behave the way we do and how we spend our money.

Appendix A

Below is survey administered to the experimental group. For simplicity of reading, certain parts of the survey was framed to group questions measuring the same construct and were labeled by the experimenter. Evidently, when the survey was presented to the participants, the questionnaire was not framed and labeled by section.

Survey

Your answers are completely confidential, and you may refuse to answer any question that you are uncomfortable answering, without penalty. There is no need to feel embarrassed about your unique traits and experiences. Everyone's different, and these differences are what interest us as psychologists. If something is not clear to you or if you are confused by any question (either language or content), please make a note of it and ask the researcher for clarification.

Label 1: Basic general information.

First Name: _____ Last Name:_____

What is your age? _____ years

What is your sex? 1. Male 2. Female

How would you describe your sexual orientation? Please circle one:

1. Heterosexual (straight) 2. Gay 3. Lesbian 4. Bisexual

How proficient would you say you are in English?

Not at all proficient		Somewhat proficient		Very proficient
1	2	3	4	5

Are you currently in a steady romantic relationship? 1. Yes 2. No

If so, how long has the relationship been going on?

_____ years _____ months _____ weeks

Please circle the highest level of education completed:

I did not finish high school

- High school
- CEGEP/DEC
- University
- Graduate school
- Post graduate

What was/ is your major? (Or what do you think it is most likely to be?) _____

What is your height? _____ feet, _____ inches OR _____ cm

What is your weight? _____ pounds OR _____kg

Label 2: Questions pertaining to the practice of skydiving.

How many skydiving jumps have you performed until now? _____ jumps

How long ago was your last jump? (if applicable)

_____years _____months _____days

Was your jump today a tandem jump?

1. Yes
2. No

With whom are you here today?

1. I came alone
2. I came with a friend. ( ) male or ( ) female?
3. I came with my significant other (boyfriend, girlfriend, spouse)
4. We came as a group
5. Other (please explain) _____

If you did not come alone, whose idea or initiative was it to skydive?

1. Mine
2. Someone else's
3. Other (please explain):_____

Please circle the highest skydiving certification attained OR are currently working on attaining:

1. None
2. Solo certificate
3. "A" CoP
4. "B" CoP
5. "C" CoP

6. “D“ CoP

How satisfied are you with the jump you performed before completing this survey?

Not at all satisfied			Neutral			Very satisfied
1	2	3	4	5	6	7

Did you ever BASE-jump?

1. Yes (How many jumps?_____)
2. No

Do you plan on BASE-jumping one day?

1. Yes
2. No
3. I don’t know

Label 3: The TIPI scale measuring the Big Five personality traits

Here are a number of personality traits that may or may not apply to you. Please write a number next to each statement to indicate the extent to which you agree or disagree with that statement . You should rate the extent to which the pair of traits applies to you, even if one characteristic applies more strongly than the other.

I see myself as:

	Disagree strongly 1	Disagree moderately 2	Disagree a little 3	Neither agree nor disagree 4	Agree a little 5	Agree moderately 6	Agree strongly 7
Extraverted, enthusiastic	○ 1	○ 2	○ 3	○ 4	○ 5	○ 6	○ 7
Critical, quarrelsome	○ 1	○ 2	○ 3	○ 4	○ 5	○ 6	○ 7
Dependable, self-disciplined	○ 1	○ 2	○ 3	○ 4	○ 5	○ 6	○ 7
Anxious, easily upset	○ 1	○ 2	○ 3	○ 4	○ 5	○ 6	○ 7
Open to new experiences, complex	○ 1	○ 2	○ 3	○ 4	○ 5	○ 6	○ 7
Reserved, quiet	○ 1	○ 2	○ 3	○ 4	○ 5	○ 6	○ 7
Sympathetic, warm	○ 1	○ 2	○ 3	○ 4	○ 5	○ 6	○ 7
Disorganized, careless	○ 1	○ 2	○ 3	○ 4	○ 5	○ 6	○ 7
Calm, emotionally stable	○ 1	○ 2	○ 3	○ 4	○ 5	○ 6	○ 7
Conventional, uncreative	○ 1	○ 2	○ 3	○ 4	○ 5	○ 6	○ 7

Label 4: The Grit Test.

Here are a number of statements that may or may not apply to you. For the most accurate score, when responding, think of how you compare to most people --- not just the people you know well, but most people in the world. There are no right or wrong answers, so just answer honestly!

I have overcome setbacks to conquer an important challenge.

1. Very much like me
2. Mostly like me
3. Somewhat like me
4. Not much like me
5. Not like me at all

New ideas and projects sometimes distract me from previous ones.

1. Very much like me
2. Mostly like me
3. Somewhat like me
4. Not much like me
5. Not like me at all

My interests change from year to year.

1. Very much like me
2. Mostly like me
3. Somewhat like me
4. Not much like me
5. Not like me at all

Setbacks don't discourage me.

1. Very much like me
2. Mostly like me
3. Somewhat like me
4. Not much like me

5. Not like me at all

I have been obsessed with a certain idea or project for a short time but later lost interest.

1. Very much like me
2. Mostly like me
3. Somewhat like me
4. Not much like me
5. Not like me at all

I am a hard worker.

1. Very much like me
2. Mostly like me
3. Somewhat like me
4. Not much like me
5. Not like me at all

I often set a goal but later choose to pursue a different one.

1. Very much like me
2. Mostly like me
3. Somewhat like me
4. Not much like me
5. Not like me at all

I have difficulty maintaining my focus on projects that take more than a few months to complete.

1. Very much like me
2. Mostly like me
3. Somewhat like me
4. Not much like me
5. Not like me at all

I finish whatever I begin.

1. Very much like me
2. Mostly like me

3. Somewhat like me
4. Not much like me
5. Not like me at all

I have achieved a goal that took years of work.

1. Very much like me
2. Mostly like me
3. Somewhat like me
4. Not much like me
5. Not like me at all

I become interested in new pursuits every few months.

1. Very much like me
2. Mostly like me
3. Somewhat like me
4. Not much like me
5. Not like me at all

I am diligent.

1. Very much like me
2. Mostly like me
3. Somewhat like me
4. Not much like me
5. Not like me at all

Label 5: The Sociosexual Orientation Inventory. Questions 1 to 3 measure the *behavior* facet, questions 4 to 6 measure the *attitude* facet, and questions 7 to 9 measure the *desire* facet.

Reminder: Your answers are completely confidential, and you may refuse to answer any question that you are uncomfortable answering, without penalty. **There is no need to feel embarrassed about your unique traits and experiences. Everyone's different, and these differences are what interest us as psychologists.**

Please respond honestly to the following questions:

1. With how many different partners have you had sex within the past 12 months?

□	□	□	□	□	□	□	□	□
0	1	2	3	4	5-6	7-9	10-19	20 or more

2. With how many different partners have you had sexual intercourse on *one and only one* occasion?

□	□	□	□	□	□	□	□	□
0	1	2	3	4	5-6	7-9	10-19	20 or more

3. With how many different partners have you had sexual intercourse without having an interest in a long-term committed relationship with this person?

□	□	□	□	□	□	□	□	□
0	1	2	3	4	5-6	7-9	10-19	20 or more

4. Sex without love is OK.

1 □	2 □	3 □	4 □	5 □	6 □	7 □	8 □	9 □
Strongly disagree								Strongly agree

5. I can imagine myself being comfortable and enjoying "casual" sex with different partners.

1 □	2 □	3 □	4 □	5 □	6 □	7 □	8 □	9 □
Strongly disagree								Strongly agree

6. I do *not* want to have sex with a person until I am sure that we will have a long-term, serious relationship.

1 □	2 □	3 □	4 □	5 □	6 □	7 □	8 □	9 □
Strongly disagree								Strongly agree

7. How often do you have fantasies about having sex with someone you are *not* in a committed romantic relationship with?

□ 1 – never

□ 2 – very seldom

□ 3 – about once every two or three months

□ 4 – about once a month

□ 5 – about once every two weeks

□ 6 – about once a week

□ 7 – several times per week

□ 8 – nearly every day

□ 9 – at least once a day

8. How often do you experience sexual arousal when you are in contact with someone you are *not* in a committed romantic relationship with?

□ 1 – never

□ 2 – very seldom

□ 3 – about once every two or three months

□ 4 – about once a month

□ 5 – about once every two weeks

□ 6 – about once a week

□ 7 – several times per week

□ 8 – nearly every day

□ 9 – at least once a day

9. In everyday life, how often do you have spontaneous fantasies about having sex with someone you have just met?

□ 1 – never

□ 2 – very seldom

□ 3 – about once every two or three months

□ 4 – about once a month

□ 5 – about once every two weeks

□ 6 – about once a week

□ 7 – several times per week

□ 8 – nearly every day

□ 9 – at least once a day

Label 6: The Mini-K scale (Life History Theory).

Please indicate how strongly you agree or disagree with the following statements. Use the scale below and circle your answer. For any item that does not apply to you, please circle "0".

	Disagree Strongly	Disagree Somewhat	Disagree Slightly	Don't Know / Not Applicable	Agree Slightly	Agree Somewhat	Agree Strongly
I can often tell how things will turn out.	-3	-2	-1	0	+1	+2	+3
I try to understand how I got into a situation to figure out how to	-3	-2	-1	0	+1	+2	+3

handle it.							
I often find the bright side to a bad situation.	-3	-2	-1	0	+1	+2	+3
I don't give up until I solve my problems.	-3	-2	-1	0	+1	+2	+3
I often make plans in advance.	-3	-2	-1	0	+1	+2	+3
I avoid taking risks.	-3	-2	-1	0	+1	+2	+3
While growing up, I had a close and warm relationship with my biological mother	-3	-2	-1	0	+1	+2	+3
While growing up, I had a close and warm relationship with my biological father	-3	-2	-1	0	+1	+2	+3
I have a close and warm relationship with my own children.	-3	-2	-1	0	+1	+2	+3
I have a close and warm romantic relationship with my sexual partner.	-3	-2	-1	0	+1	+2	+3
I would rather have one than several sexual relationships at a time.	-3	-2	-1	0	+1	+2	+3
I have to be closely attached to someone before I am comfortable having sex with them.	-3	-2	-1	0	+1	+2	+3
I am often in social contact with my blood relatives.	-3	-2	-1	0	+1	+2	+3
I often get emotional support and practical help from my blood relatives.	-3	-2	-1	0	+1	+2	+3
I often give emotional support and practical help to my blood relatives.	-3	-2	-1	0	+1	+2	+3
I am often in social contact with my friends.	-3	-2	-1	0	+1	+2	+3
I often get emotional support and practical help from my friends.	-3	-2	-1	0	+1	+2	+3
I often give emotional support and practical help to my friends.	-3	-2	-1	0	+1	+2	+3
I am closely connected to and involved in my community.	-3	-2	-1	0	+1	+2	+3
I am closely connected to and involved in my religion.	-3	-2	-1	0	+1	+2	+3

Label 7: The Sensation Seeking Scale form V.

Directions: Each of the items below contains two choices, A and B. Please indicate (circle) on your answer sheet which of the choices most describes your likes or the way you feel. In some cases you may find items in which both choices describe your likes or feelings. Please choose the one which better describes your likes or feelings.
In some cases you may find items in which you do not like either choice. In these cases mark the choice you dislike least. Please try to answer each item.
It is important you respond to all items with only one choice, A or B. We are interested only in your likes or feeling, not in how others feel about these things or how one is supposed to feel. There are no right or wrong answers as in other kinds of tests. Be frank and give your honest appraisal of yourself.

1. A. I like "wild" uninhibited parties
   B. I prefer quiet parties with good conversation
2. A. There are some movies I enjoy seeing a second or even a third time
   B. I can't stand watching a movie that I've seen before
3. A. I often wish I could be a mountain climber
   B. I can't understand people who risk their necks climbing mountains
4. A. I dislike all body odors
   B. I like some for the earthly body smells
5. A. I get bored seeing the same old faces
   B. I like to comfortable familiarity of everyday friends
6. A. I like to explore a strange city or section of town by myself, even if it means getting lost
   B. I prefer a guide when I am in a place I don't know well
7. A. I dislike people who do or say things just to shock or upset others
   B. When you can predict almost everything a person will do and say he or she must be a bore
8. A. I usually don't enjoy a movie or play where I can predict what will happen in advance
   B. I don't mind watching a movie or a play where I can predict what will happen in advance
9. A. I have tried marijuana or would like to
   B. I would never smoke marijuana
10. A. I would not like to try any drug which might produce strange and dangerous effects on me
    B. I would like to try some of the new drugs that produce hallucinations
11. A. A sensible person avoids activities that are dangerous
    B. I sometimes like to do things that are a little frightening
12. A. I dislike "swingers" (people who are uninhibited and free about sex)
    B. I enjoy the company of real "swingers"
13. A. I find that stimulants make me uncomfortable
    B. I often like to get high (drinking liquor or smoking marijuana)
14. A. I like to try new foods that I have never tasted before
    B. I order the dishes with which I am familiar, so as to avoid disappointment and unpleasantness
15. A. I enjoy looking at home movies or travel slides
    B. Looking at someone's home movies or travel slides bores me tremendously

16. A. I would like to take up the sport of water skiing
    B. I would not like to take up water skiing
17. A. I would like to try surf boarding
    B. I would not like to try surf boarding
18. A. I would like to take off on a trip with no preplanned or definite routes, or timetable
    B. When I go on a trip I like to plan my route and timetable fairly carefully
19. A. I prefer the “down to earth” kinds of people as friends
    B. I would like to make friends in some of the “far out” groups like artists or “punks”
20. A. I would not like to learn to fly an airplane
    B. I would like to learn to fly an airplane
21. A. I prefer the surface of the water to the depths
    B. I would like to go scuba diving
22. A. I would like to meet some persons who are homosexual (men or women)
    B. I stay away from anyone I suspect of being “gay or lesbian”
23. A. I would like to try parachute jumping
    B. I would never want to try jumping out of a plane with or without a parachute
24. A. I prefer friends who are excitingly unpredictable
    B. I prefer friends who are reliable and predictable
25. A. I am not interested in experience for its own sake
    B. I like to have new and exciting experiences and sensations even if they are a little frightening, unconventional, or illegal
26. A. The essence of good art is in its clarity, symmetry of form and harmony of colors
    B. I often find beauty in the “clashing” colors and irregular forms of modern paintings
27. A. I enjoy spending time in the familiar surroundings of home
    B. I get very restless if I have to stay around home for any length of time
28. A. I like to dive off the high board
    B. I don’t like the feeling I get standing on the high board (or I don’t go near it at all)
29. A. I like to date members of the opposite sex who are physically exciting
    B. I like to date members of the opposite sex who share my values
30. A. Heavy drinking usually ruins a party because some people get loud and boisterous
    B. Keeping the drinks full is the key to a good party
31. A. The worst social sin is to be rude
    B. The worst social sin is to be a bore
32. A. A person should have considerable sexual experience before marriage
    B. It’s better if two married persons begin their sexual experience with each other
33. A. Even if I had the money I would not care to associate with flight rich persons like those in the “jet set”
    B. I could conceive of myself seeking pleasures around the world with the “jet set”
34. A. I like people who are sharp and witty even if they do sometimes insult others
    B. I dislike people who have their fun at the expense of hurting the feelings of others
35. A. There is altogether too much portrayal of sex in movies
    B. I enjoy watching many of the “sexy” scenes in movies

36. A. I feel best after taking a couple of drinks
    B. Something is wrong with people who need liquor to feel good
37. A. People should dress according to some standard of taste, neatness, and style
    B. People should dress in individual ways even if the effects are sometimes strange
38. A. Sailing long distances in small sailing crafts is foolhardy
    B. I would like to sail a long distance in a small but seaworthy sailing craft
39. A. I have no patience with dull or boring persons
    B. I find something interesting in almost every person I talk to
40. A. Skiing down a high mountain slope is a good way to end up on crutches
    B. I think I would enjoy the sensations of skiing very fast down a high mountain slope

Label 8: Brief cognitive test.

The following three questions are designed to test your basic cognitive problem solving skills:

A bat and a ball cost $1.10 in total. The bat costs $1.00 more than the ball. How much does the ball cost? Please enter your answer in the form x.xx.

Answer: _____

If it takes 5 machines 5 minutes to make 5 widgets, how long (in minutes) would it take 100 machines to make 100 widgets? (please just enter a number, and do not write "minutes")

Answer: _____

In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long (in days) would it take for the patch to cover half of the lake? (please just enter a number, and do not write "days")

Answer: _____

Label 9: Additional general information regarding siblings, ethnicity and health.

How many brothers and sisters (full siblings) do you have altogether? _____
How many of them are older brothers? _____
How many of them are older sisters? _____
How many of them are younger brothers? _____
How many of them are younger sisters? _____

How many half-siblings (one parent in common) do you have altogether? _____
How many of them are older step-brothers or half-brothers? _____
How many of them are older step-sisters or half-sisters? _____
How many of them are younger step-brothers or half-brothers? _____
How many of them are younger step-sisters or half-sisters? _____

How would you describe your race or ethnicity? Check any and all that apply.
1. White / Caucasian
2. Hispanic, Latino, Chicano, Mexican American, or Puerto Rican
3. Black / African American
4. American Indian / Alaskan Native
6. Asian American / Asian
7. Middle Eastern
8. Other (please specify: _____)

Do you currently suffer from any health issues? (eg. Infections, headache, autoimmune disease, respiratory problems)

1. Yes (Please specify:_____)
2. No

Do you currently take medication?

3. Yes (Please specify: _____)
4. No

Do you have any feedback or thoughts about this survey that you would like to share?

Appendix B

The survey given to control participants was identical to the one given to the experimental group with some small exceptions. The questions related to skydiving were removed and were replaced by similar questions regarding their choice of physical activity and the frequency of participating in it. The questions are:

How often do you engage in a physical activity (i.e. train, workout)?

a) Almost daily
b) 2-4 times per week
c) About once a week
d) Once every few weeks

What is the physical activity that you engage in the most? (i.e. gym workout, soccer, tennis, etc)

_____

How long have you been regularly doing this activity?

_____years _____months _____days

Are there other physical activities that you engage in on a regular basis?

1.Yes, please specify_____
2. No

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