The Effects of Testosterone Indicators on Consumer Risk-Taking

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A Thesis
In the Department
of
Marketing

Presented in Partial Fulfillment of the Requirements
For the Degree of
Doctor of Philosophy (Business Administration) at
Concordia University
Montreal, Quebec, Cananda

April 2014

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CONCORDIA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

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and submitted in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY (Administration)

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ABSTRACT

The Effects of Testosterone Indicators on Consumer Risk-Taking

Eric Stenstrom
Concordia University, 2014

Although extensive research has examined physiological influences on consumer behavior, how hormones influence risk-taking behavior is not yet well understood. My dissertation focuses on how testosterone might influence consumer risk-taking. In paper one (Stenstrom & Saad, 2011), the literature on testosterone and risk-taking is reviewed. We argue that testosterone has organizational and activational effects on both financial risk-taking and pathological gambling. In paper two (Stenstrom, Saad, Nepomuceno, & Mendenhall, 2011), we focus on the organizational effects of testosterone on risk-taking. Specifically, the association between digit ratio, a proxy of prenatal testosterone exposure, and risk-taking across five domains (recreational, social, financial, health-related, and ethical) is investigated. We find that digit ratio is predictive of risk-taking propensity in recreational, social, and financial (but not health-related or ethical) domains in Caucasian males. In paper three (Stenstrom & Saad, Working Paper), we shift our attention towards activational effects of testosterone on risk-taking. We investigate how exposure to babies, which purportedly elicits testosterone changes, influences risk-taking. In particular, we show that exposure to visual baby stimuli leads to lesser risk-taking among non-parents, while eliciting greater risk-taking among parents. Further, we find that baby sounds (laughs and cries) lead to lesser risk-taking in non-parents. Taken together, the three papers herein suggest that testosterone has both organizational and

activational effects on consumer risk-taking, and that future research would benefit from considering hormonal, evolutionary, and social influences on risk-taking.

DEDICATION

I dedicate my thesis entirely to my wife Carrie, who has been infinitely supportive, patient, and loving throughout my graduate studies.

CONTRIBUTION OF AUTHORS

This section discusses the author contributions for each of the papers contained in this thesis, as required by thesis regulations. While I've done my best to describe the contributions as accurately as possible below, I apologize to my coauthors if I have made any errors or omissions (memory can be faulty).

Dr. Saad and I both contributed extensively to paper one. I came up with the idea for the paper as part of Dr. Julien Doyon's Neuropsychopathology class at Université de Montréal. Dr. Doyon provided some initial feedback on the initial 14-page draft (including references) that I submitted as a mid-term paper. I then worked with Dr. Saad through multiple rounds of revisions to improve and expand it into a 19-page review manuscript. Dr. Saad provided extremely thorough and detailed feedback and modifications during each round of these revisions, whereas I would incorporate his feedback by rewriting substantial parts of the manuscript. We first submitted it to *Neuroscience & Biobehavioral Reviews*, where it was rejected. After I incorporated the reviewers' feedback, we submitted our revised manuscript to JNPE where it was eventually accepted after 3 rounds of revisions. I lead each round of journal revisions (drafting the revisions and the responses to the reviewers and then incorporating Dr. Saad's feedback by rewriting substantial parts of the manuscript subsequent to his feedback), while Dr. Saad provided extensive and meticulous feedback and revisions at each round. Our final published manuscript is 44 pages long with references (25 pages longer than it was at the start of the journal review process).

I developed the idea for paper two with the help of Dr. Saad as part of his Evolutionary Consumption and Behavioral Decision Making course at Concordia

University. I collected the data, with the help of classmates Marcelo Nepomuceno and Zack Mendenhall, as part of my course project in Dr. Saad's course. I ran the analyses and then presented the project in class and received exhaustive feedback from Dr. Saad. Subsequently, Zack Mendenhall, Marcelo Nepomuceno, and I worked together to run the additional analyses and write the first draft of the manuscript (I led the process). We then went through multiple rounds of revisions with Dr. Saad, who provided extremely meticulous and exhaustive feedback and revisions at each round. The manuscript that we initially submitted to *Personality and Individual Differences* was 21 pages long (it was just under the 5,000 word limit required by *Personality and Individual Differences*). We first received a revise & resubmit. I lead the revisions and response to reviewers with the help of Zack Mendenhall and Marcelo Nepomuceno, and we went back and forth with Dr. Saad who gave detailed and extensive feedback and made direct modifications throughout the process. We then resubmitted our manuscript (still 21 pages with references, just under the 5,000-word limit), which was eventually accepted for publication.

For the third and final paper, Dr. Saad and I both contributed extensively. I thought of the initial idea of studying the effects of baby exposure on risk-taking, while Dr. Saad thought of the idea of studying this phenomenon using different communication modalities. Dr. Saad and I ironed out the idea for the project and designed the experimental design for the two studies via numerous discussions. I constructed the online survey using Qualtrics, and Dr. Saad provided extensive feedback throughout this process. Qualtrics Panels ran the two online data collection processes. I analyzed the results for both studies. Before study 2 was conducted, I wrote the initial draft of the

paper that included only study 1 (20 pages) and sent it to Dr. Saad. He sent it back to me with enormously thorough and meticulous feedback and revisions. After study 2 was conducted, I drafted all of the sections relating to this study and incorporated it into the manuscript. Dr. Saad and I then went back and forth numerous times to revise the manuscript. At each round of revisions, Dr. Saad provided extremely extensive and detailed feedback and revisions, while I implemented his feedback by rewriting much of the paper and adding substantial parts. The revised manuscript (with references) herein is 45 pages long.

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INTRODUCTION

Despite the large body of work exploring consumer behavior from a physiological perspective (Aaker, Stayman, and Hagerty, 1986; Frost & Stauffer, 1987; Hazlett & Hazlett, 1999; Hedgcock & Rao, 2009; Yoon, Gutchess, Feinberg, & Polk, 2006), how hormones impact consumer risk-taking behavior is not yet well understood. In this dissertation, I present three papers that attempt to fill this gap in the literature by investigating novel ways in which testosterone may impact consumer risk-taking.

I begin with a review paper in which Gad Saad and I provide a comprehensive examination of the literature relating to testosterone and risk-taking (paper one; Stenstrom & Saad, 2011). Further, we explore if testosterone has organizational (developmental) and activational (real-time) influences on both financial risk-taking and one's susceptibility to succumbing to pathological gambling. In paper two, Gad Saad, Marcelo Nepomuceno, Zack Mendenhall, and I examine the association between digit ratio, a purported marker of prenatal testosterone exposure, and consumer risk-taking (Stenstrom et al., 2011). While the great majority of the research on testosterone and risk-taking focuses solely on financial contexts, we investigate the association between digit ratio and risk-taking across five different domains (recreational, financial, social, ethical, and health-related). In paper three, we turn our attention to the activational effects of testosterone on risk-taking. Gad Saad and I investigate how baby exposure, a purported driver of circulating testosterone levels, impacts risk-taking (Stenstrom & Saad, Working Paper). Specifically, we examine how exposure to baby photos and sounds influences consumer risk-taking, and we explore how parental status (parents and non-parents) and emotional valance (crying and laughter) might moderate these effects.

Before presenting paper one, I provide a conceptual overview of the research on testosterone and risk-taking in the ensuing section. While paper one provides a very comprehensive and thorough review of the literature on testosterone and risk-taking, it does not cover much of the conceptual development relating to the effects of parenthood and baby exposure on testosterone and risk-taking that is central to paper three. Accordingly, the next section offers a general conceptual overview that fully encompasses all three papers contained in this thesis.

CONCEPTUAL OVERVIEW

Testosterone is a masculinizing hormone that has both organizational (i.e., developmental) effects on the brain, and activational (i.e., real-time) effects on behavior. The organizational effects of testosterone occur mainly during the two most significant developmental stages, namely in utero and at puberty (Archer, 2006; Mazur & Booth, 1998). In utero, the amount of testosterone exposure has an impact on the masculinization of the fetal brain organization, which ultimately influences sexually differentiated behaviors later in life (Auyeung et al., 2009; Breedlove & Hampson, 2002; Udry, 2000). Prenatal testosterone also has an effect on finger length, by decreasing the growth of the second digit in relation to the other three digits (Lutchmaya, Baron-Cohen, Raggatt, Knickmeyer, & Manning, 2004; Manning, Scutt, Wilson, & Lewis-Jones, 1998). Consequently, digit ratio (mainly 2D:4D, i.e., the length of the second digit relative to the fourth digit) is commonly used as a marker of prenatal testosterone (Manning et al., 1998; Manning et al., 2003). Digit ratio has been associated with a variety of sexually differentiated traits in both men and women, including athletic ability (Manning & Taylor, 2001; Paul, Kato, Hunkin, Vivekanandan, & Spector, 2006), sex role identity (Csatho et al., 2003), and aggression (McIntyre et al., 2007; see Voracek & Loibl, 2009 for a review of digit ratio research). Another purported proxy of organizational testosterone is facial masculinity (e.g., prominence of lower jaw and brow ridges), which is indicative of testosterone levels during sexual development at puberty (Johnston, Hagel, Franklin, Fink, & Grammer, 2001). Similarly to digit ratio, facial masculinity has been associated with sexually differentiated traits (Apicella et al., 2008; Carré & McCormick, 2008).

While the organizational effects of testosterone on behavior involve sexually differentiated traits, research on the activational effects of testosterone on behavior tend to involve competitive challenges, mating opportunities, and parenthood (Archer, 2006; van Anders, Goldey, & Kuo, 2011). According to the Challenge Hypothesis (Archer, 2006), circulating testosterone levels increase in response to challenges such as intra-sexual sporting events (Bateup et al., 2002; Booth et al., 1989), and to mating-related situations such as sexual arousal (Hellhammer et al., 1985; Stoléru, Ennaji, Cournot, & Spira, 1993; Stoléru et al., 1999) and being in the presence of attractive individuals of the opposite sex (Roney et al., 2003; Ronay & von Hippel, 2010). In contrast, testosterone levels decrease in response to becoming a new parent (Berg & Wynne-Edwards, 2001; Gettler, McDade, Feranil, & Kuzawa, 2011; Gray, 2011), engaging in parental activities (Gettler et al., 2011), and listening to baby cries in a nurturing parental context (van Anders, Tolman, & Volling, 2012). Hence, competitive challenges and mating-related situations elicit an increase in testosterone levels, whereas parenting elicits a decrease in testosterone.

In paper one, we review the literature both on the organizational and activational effects of testosterone on risk-taking. Further, we investigate if testosterone is associated with pathological gambling. We contend that circulating testosterone levels, digit ratio, and facial masculinity may be predictors of financial risk-taking and pathological gambling susceptibility.

Our review of the literature in paper one shows that the great majority of the research on testosterone and risk-taking focuses on the financial domain. However, in paper two, we examine if testosterone has organizational effects on risk-taking across

various different domains. Studies have shown that an individual may exhibit a strong propensity to engage is risk-taking in one domain (e.g., financial) while being extremely risk aversive in another domain (e.g., recreational). Therefore, we investigate the association between digit ratio and risk-taking across five domains, namely financial, recreational, social, ethical, and health-related. Our results demonstrate that low digit ratio (a proxy of high prenatal testosterone) was predictive of high financial, recreational, and social (but not ethical and health-related) risk-taking in Caucasian males.

In paper three, we shift our attention from organizational effects to activational ones. While parenthood has been shown to elicit a decrease in testosterone, we examine if merely being exposed to baby stimuli leads to a reduction in risk-taking, presumably via a decrease in testosterone. Despite the substantial research on the effects of baby stimuli on perceptions of cuteness and care-taking motives, little is known about how baby stimuli impact risk-taking. Across two studies, we investigate how exposure to baby photos and sounds influences risk-taking, and how these effects might be moderated by emotional valence (laughs vs. cries) and parental status (parents vs. non-parents).

Overall, the three papers herein explore novel ways that testosterone might have organizational and activational effects on consumer risk-taking. In the following section, I present paper one titled "Testosterone, Financial Risk-Taking, and Pathological Gambling," published in *Journal of Neuroscience, Psychology, and Economics* (Stenstrom & Saad, 2011).

PAPER 1: TESTOSTERONE, FINANCIAL RISK-TAKING, AND PATHOLOGICAL GAMBLING

Abstract

The current review article considers the relationship between testosterone and pathological gambling (PG). Recent evidence suggests that high-testosterone individuals have a greater appetite for financial risk-taking and are more likely to succumb to certain impulsivity-related pathologies. Further, two markers of androgenization have recently been shown to be predictive of financial risk-taking propensity, namely second-to-fourth digit length ratio and facial masculinity. Given that financial risk-taking propensity and PG susceptibility share neurobiological and phenomenological similarities, it is argued in this review that circulating testosterone levels, second-to-fourth digit length ratio, and facial masculinity may be predictors of PG susceptibility. Potential caveats and future research avenues are discussed.

Introduction

Pathological gambling (PG) is an impulse control disorder characterized by recurring, uncontrolled gambling (American Psychiatric Association, 1994). The social and economic repercussions of PG are staggering. Pathological gamblers accumulate an average of $50,000 to $90,000 in gambling debts (Lamberton & Oei, 1997), yielding a wide range of deleterious effects on their familial, personal, and vocational lives. PG afflicts a substantial number of individuals, with its prevalence in North America approximated at 1% of the general population (Potenza, Kosten, & Rounsaville, 2001; Shaffer, Hall, & Vander Bilt, 1999).

Recent cognitive and neuroimaging research has shed light on the neurocognitive underpinnings of PG (van Holst, van den Brink, Veltman, & Goudriaan, 2010). Though twin studies and modern genetic methods have underlined the strong genetic basis of PG, much of the variance in individual susceptibility has yet to be explained. Of all possible demographic variables, sex is the strongest predictor of the psychopathology with men being at an estimated 271% greater risk of succumbing to PG compared with women (Volberg, Abbott, Ronnberg, & Munck, 2001). In addition, the male effect in PG is strongly robust cross-culturally (Gray, 2004). Numerous other psychiatric disorders appear to have an epidemiology that is strongly sex-specific including eating disorders, pornographic addictions, compulsive buying, and excessive sun tanning (Saad, 2007a, chapter 6). Given that the sex specificity of each of these disorders is invariant to cultural and/or temporal settings, it is indicative of a Darwinian etiology. Other sex differences in psychiatric disorders that have been explored from an evolutionary perspective include OCD (Saad, 2006a), and global ratios of suicide (Saad, 2007b). Whereas providing explanations for between-sex differences is the more frequent issue addressed by evolutionary psychologists, it is imperative to tackle the factors that drive within-sex differences in the proclivity to succumb to specific psychiatric disorders. Given that testosterone plays a major role in male sexual development, can individual differences in testosterone levels and androgenization account for some of the individual variance in PG susceptibility? In the current review paper, we examine the links between testosterone, financial risk-taking, and PG.

First, the research examining the neurogenetic and phenomenological evidence linking financial risk-taking to PG is reviewed. The evidence suggests that financial risk-

taking propensity and PG share common neurobiological underpinnings relating to dopaminergic and serotonergic function, as well as phenomenological similarities. We then discuss research that has linked testosterone to PG susceptibility, including studies connecting testosterone to other impulsivity-related pathologies. Next, we review research associating testosterone and markers of androgenization to financial risk-taking propensity. The literature suggests that (1) circulating testosterone levels are associated with financial risk-taking, and (2) two markers of testosterone levels during critical periods of sexual development, second-to-fourth digit length ratio (2D:4D) and facial masculinity, are predictive of financial risk-taking propensity and may be predictive of PG susceptibility. We subsequently identify potential future research avenues, followed by a general discussion including limitations.

Neurogenetics, Financial Risk-Taking, and PG

Recent neurogenetic findings suggest that financial risk-taking propensity and PG have shared neurobiological underpinnings. Using a twins design, Zhong et al. (2009a) found that genetics explained approximately 57% of the variance in attitudes toward economic risk. Cesarini and colleagues documented more modest effects in their twin design studies, estimating that genes accounted for 20% of the variance in financial risk-taking preferences using an experimental approach with survey data (Cesarini, Dawes, Johannesson, Lichtenstein, & Wallace, 2009), and 25% of the variance in risk-taking using a field approach with actual pension investment data (Cesarini, Johannesson, Lichtenstein, Sandewall, & Wallace, 2010). Research examining specific DNA sequence polymorphisms have linked financial risk-taking propensity to polymorphisms of genes

related to dopaminergic and serotonergic function. Essentially, dopamine is involved in motivation, reward- seeking, motor control, and learning (Arias-Carrión & Pöppel, 2007), whereas serotonin is predominantly implicated in appetite, mood, stress response, and emotional regulation (Berger, Gray, & Roth, 2009). Dreber et al. (2009) found that polymorphisms of the dopamine receptor D4 gene (the presence or absence of the 7-repeat allele in the DRD4 gene) explained 5% of the variance in risk-taking propensity in a financial investment task, though they did not observe an association between risk-taking and polymorphisms of a second dopamine receptor gene (DRD2). Furthermore, Kuhnen and Chiao (2009) showed that carriers of the 7-repeat allele in the DRD4 gene took approximately 25% more risks in financial investment decisions. In addition, they established that carriers of two short alleles of the serotonin transporter gene 5-HTT took roughly 28% less risks. Crisan et al. (2009) also found that carriers of two short alleles of the serotonin transporter gene 5-HTT exhibited reduced risk-taking, though Roiser et al. (2009) did not replicate this effect. Zhong et al. (2009b) found that polymorphisms of the monoamine oxidase A gene (MAOA), a gene variant linked to serotonergic function, was linked to long-shot financial risk-taking. Frydman, Camerer, Bossaerts, and Rangel (2011) showed that a MAOA polymorphism was associated with making financially riskier choices and with making better financial decisions under uncertainty, although they found no such effects for 5-HTT or DRD4 polymorphisms. Carpenter, Garcia, and Lum (2011) did not replicate the effect of the 7-repeat allele of the DRD4 gene on financial risk-taking obtained by both Dreber et al. (2009) and Kuhnen and Chiao (2009; Carpenter et al. actually found a marginally significant effect in the opposite direction). However, they did show that 7-repeat allele carriers made riskier choices when

probabilities were ambiguous. Seven-repeat carriers were also more likely to discount the future and less likely to make prudent banking choices (e.g., pay their credit card balance each month). Further, in a field study, bridge players with the 7-repeat allele in the DRD4 gene took 14% more risks when making bids at a contract bridge championship, and took greater financial risks in an investment game, though this effect was only found among men (Dreber et al., 2011). Eisenegger et al. (2010a) found no significant effects of DRD4 polymorphisms on financial risk-taking, although an interaction effect did emerge wherein individuals who were both administered a dopaminergic drug treatment, and who were carriers of the 7-repeat allele engaged in greater risk-taking. Gene polymorphisms relating to dopaminergic and serotonergic function have also been implicated in valuation of gains and losses under uncertainty (Crisan et al., 2009; Roiser et al., 2009; Zhong et al., 2009c). Taken together, these findings suggest that financial risk-taking proclivity is significantly influenced by polymorphisms of genes involved in dopaminergic and serotonergic function.

PG has also been shown to have a strong genetic component (Ibáñez, Blanco, Perez de Castro, Fernandez-Piqueras, & Sáiz-Ruiz, 2003; Shah, Eisen, Xian, & Potenza, 2005). A study conducted on a sample of 3,359 male twin pairs reported that genetics accounted for 35 to 54% of the liability for exhibiting symptoms of PG (Eisen et al., 1998). Perez de Castro, Ibáñez, Torres, Sáiz-Ruiz, and Fernandez-Piqueras (1997) found that the 7-repeat allele of the DRD4 gene was significantly more likely to be present in pathological gamblers. Polymorphisms of the DRD2 gene have also been linked to PG (Comings et al., 1996). Further, polymorphisms of the serotonin transporter gene 5-HTT were found to be predictive of one's likelihood to engage in PG (Perez de Castro, Ibáñez,

Sáiz- Ruiz, & Fernandez-Piqueras, 1999, 2002). Although some studies have yielded mixed or null results (Carpenter et al., 2011; Roiser et al., 2009), the aggregated evidence suggests that polymorphisms of genes involved in dopaminergic and serotonergic function are associated with both financial risk-taking and PG. Hence, financial risk-taking and PG share common neurobiological underpinnings such that they both involve dopaminergic and serotonergic pathways.

The association between PG and financial risk-taking is further supported by phenomenological similarities. Mishra, Lalumière, and Williams (2010) showed that problem gambling and general gambling involvement were positively correlated with risk-accepting attitudes (relating to financial investing, gambling, safety, ethics, and overall risk), as well as with personality traits associated with risk-taking such as sensation seeking, impulsivity, and lack of self-control. These findings suggest that problem gambling is a manifestation of a greater general proclivity toward risk-taking. Thus, financial risk-taking proclivity and PG susceptibility appear to share both neurobiological and phenomenological commonalities.

Despite these neurogenetic findings linking PG and financial risk-taking to genes involved in dopaminergic and serotonergic function, no research to date has examined the potential influence of gene polymorphisms involved in androgenic function (i.e., relating to testosterone) on financial risk-taking or PG. In the ensuing section, we review the evidence linking PG to individual differences in testosterone levels.

Testosterone and PG

Testosterone may be a hormonal pathway by which part of the genetic transmission of one's susceptibility to PG operates. Apicella et al. (2008) proposed that the genetic transmission of risk-taking might function in part via androgenic pathways. In line with this reasoning, testosterone levels are strongly hereditable. Twin and sibling studies have revealed that genes account for between 50% and 65% of the variance in testosterone levels (Bogaert et al., 2008; Hoekstra, Bartels, & Boomsma, 2006; Kuijper et al., 2007). Given the neurobiological and phenomenological commonalities between financial risk-taking propensity and gambling, it is feasible that part of the genetic variation in PG susceptibility may be accounted for by individual differences in testosterone levels.

Initial evidence in support of the testosterone-PG link comes from studies associating testosterone with other impulsivity-related pathologies. Generally, individual differences in basal testosterone levels have been positively associated with various phenomena such as athletic ability (Edwards, Wetzel, & Wyner, 2006), social dominance (Mazur & Booth, 1998), occupational status (Dabbs, Alford, & Fielden, 1998), and new venture creation (White, Thornhill, & Hampson, 2007). As for impulsive dispositions, Dabbs and colleagues have found that testosterone levels are positively correlated with violent and aggressive behavior in both women (Dabbs & Haregrove, 1997) and men (Dabbs & Morris, 1990; Dabbs, Carr, Frday, & Riad, 1995; see Mazur & Booth, 1998 for a review). Moreover, testosterone has been associated with disinhibition (Daitzman, Zuckerman, Sammelwitz, & Ganjam, 1978), anti-social behavior (Stalenheim, Eriksson, von Knorring, & Wide, 1998), and sensation seeking (Campbell et al., 2010; Gerra et al.,

1999). A similar pattern of impulse-related dispositions has been found in pathological gamblers including a greater incidence of antisocial behaviors, aggression, impulsivity (Parke & Griffiths, 2004; Steel & Blaszczynski, 1998), and novelty seeking (Nordin & Nylander, 2007). Incidentally, other testosterone-related morphologic traits have been linked to impulsivity-related pathologies and/or to behaviors that yield deleterious consequences to self or others. For instance, Carré & McCormick (2008) showed that men with more masculinised facial metrics (higher facial width-to-height ratio) tend to behave more aggressively. Further, Wilson and Herrnstein (1985) discuss research showing that individuals with mesomorphic body types are much more likely to be violent criminals than those with other somatypes (i.e., endomorphic or ectomorphic). To the extent that mesomorphs are more likely to possess higher basal T levels (as manifested via their greater athleticism, musculature, and facial features), this suggests that testosterone markers can be predictive of criminality. In summary, PG shares a common etiology with other impulsivity-related pathologies that have been linked to testosterone.

Blanco, Ibáñez, Blanco-Jerez, Baca-Garcia, and Sáiz-Ruiz (2001) were the first to directly investigate the link between individual differences in testosterone levels and PG. They found that a sample of 29 male pathological gamblers had similar basal testosterone levels to their healthy counterparts. The researchers concluded that testosterone levels were not likely to be related to PG. However, their findings might be confounded by the winner-loser effect on testosterone levels. Specifically, the basal testosterone levels of pathological gamblers measured at the time of the study might have been significantly lower than if these testosterone levels would have been measured before the individuals

had ever gotten involved in gambling. Testosterone levels are very sensitive tothe results of competition (Mazur & Lamb, 1980; see Salvador & Costa, 2009, for a review; however, see Steiner, Barchard, Meana, Hadi, & Gray, 2010, wherein no winner–loser effect was found subsequent to poker play), to vicarious experiences of sports results among fans (Bernhardt, Dabbs, Fielden, & Lutter, 1998), and to changes in social status (Mazur & Booth, 1998). Further, Coates and Herbert (2008) found that testosterone levels of financial traders (measured at 11:00 a.m. and 4:00 p.m.) were positively correlated to daily earnings. Moreover, they showed that lower T levels in the morning were predictive of lower earnings that day. Hence, financial wins and losses seem to influence testosterone levels, which, in turn, appear to influence financial decision-making. This winner-loser effect might be operative in PG, such that testosterone levels of pathological gamblers are likely to fluctuate considerably as a result of the monetary loses and gains inherent to gambling. Given that (1) pathological gamblers tend to lose money more often than win, (2) they are more likely to experience losses in their occupation (e.g., demotion, job loss) and social realms (e.g., divorce, loss of house) because of their gambling, (3) losses tend to lower testosterone levels, and (4) winner–loser effects on testosterone levels can last for days (Mazur & Lamb, 1980), their basal testosterone levels might shift downward considerably for as long as they are gambling daily. Therefore, if high testosterone individuals are more susceptible to becoming pathological gamblers, this association might not show up when comparing the testosterone levels of pathological gamblers to those of healthy individuals, as did Blanco et al. (2001). Because there is no research to date directly examining the effects of gambling wins and losses on testosterone levels among pathological gamblers, further

research testing this potential confound is warranted. Aside from Blanco et al., no research has directly investigated a potential link between individual differences in testosterone levels and gambling behavior in a sample of pathological gamblers. Therefore, in the following section, we discuss studies using nonclinical samples that have looked at the relationship between financial risk-taking and testosterone (including markers of androgenization).

Testosterone and Financial Risk-Taking Propensity

Using a single-item investment game with real potential monetary payoffs, Apicella et al. (2008) showed that testosterone levels were positively correlated with financial risk-taking propensity in a sample of 98 healthy male students. Likewise, White, Thornhill, and Hampson (2006) found that testosterone levels were positively associated with new venture creation (hence an element of risk was inherent) in a sample of healthy male students. Moreover, they showed that this testosterone effect was partially mediated by risk preferences, with testosterone levels being positively correlated with risk-taking and entrepreneurship. In a sample of 550 healthy male and female students, Sapienza, Zingales, and Maestripieri (2009) investigated the effects of testosterone on risk aversion using a similar investment game. They reported a significant negative correlation between basal testosterone levels (determined by the average of a pretest and a posttest saliva sample) and risk aversion among women, though this relationship was small and did not reach statistical significance among men. Additionally, van Honk et al. (2004) showed that a single administration of testosterone to a sample of 12 healthy women triggered a riskier, more disadvantageous pattern of decision making in the Iowa

gambling task compared with a placebo administration. Despite the small women-only sample, this finding suggests that testosterone could have a direct influence on reward-punishment contingencies in individuals by biasing them toward riskier financial gambles. Furthermore, Stanton, Liening, and Schultheiss (2011) reported that basal testosterone levels (assessed via saliva sampling) were positively correlated with riskier, less advantageous choices in the Iowa gambling task among both men and women, with stronger effects exhibited by women. Stanton et al. (2011b) uncovered a U-shaped relationship between testosterone (saliva sampling) and financial risk-taking among men and women, such that low- and high-testosterone individuals exhibited greater financial risk-taking than those with intermediate levels of testosterone. In a sample of postmenopausal women, Zethraeus et al. (2009) found no effects of testosterone treatments on financial risk-taking and other economic behavior (e.g., ultimatum game) over a period of 4 weeks. However, two recent studies have shown that testosterone treatments did influence financial bargaining behavior in ultimatum games, albeit the effects were different across the two sexes. More precisely, testosterone administration elicited lower offers compared with placebo treatments in a male sample (Zak et al., 2009) while inducing higher offers compared with placebo administration in a female sample (Eisenegger et al., 2010b). Overall, the evidence suggests that testosterone is positively associated with financial risk-taking proclivity, albeit a few studies have produced null or mixed effects.

Financial risk-taking propensity has also been associated with proxies of androgenization. Generally, androgenization via the exposure to prenatal testosterone influences brain organization and future sex-specific behaviors (Archer, 2006; Breedlove

& Hampson, 2002). Fetal testosterone levels measured from amniotic fluid have been found to correlate positively with male-typical behaviors and interests among women (Udry, 2000), male typical play in boys and girls (Auyeung et al., 2009a), and the number of autistic traits exhibited by boys and girls (Auyeung et al., 2009b). 2D:4D is thought to be a marker of prenatal testosterone exposure during brain organization (Manning, Scutt, Wilson, & Lewis-Jones, 1998). Support for 2D:4D being a proxy of prenatal testosterone exposure comes from several sources. First, low right-hand 2D:4D in 2-year-olds was associated with high fetal testosterone levels (relative to estrogen) extracted from amniotic fluid during a routine amniocentesis over 2 years before the digit ratio measurements (Lutchmaya, Baron-Cohen, Raggatt, Knickmeyer, & Manning, 2004). Second, 2D:4D is sexually dimorphic, with boys, on average, having lower digit ratios than girls by the age of two (Manning et al., 1998). Males are also exposed to higher levels of prenatal testosterone, with fetal testosterone levels obtained from amniotic fluid being higher in males than in females (Lutchmaya et al., 2004). Finally, men and women who suffer from congenital adrenal hyperplasia (overproduction of androgens commencing in utero) tend to have much lower 2D:4D (Brown, Hines, Fane, & Breedlove, 2002). Overall, the evidence suggests that 2D:4D is a valid proxy of prenatal testosterone exposure (McIntyre, 2006). 2D:4D is largely heritable, with genetics explaining an estimated 66% of the variance in 2D:4D in a twin study (Paul, Kato, Cherkas, Andrew, & Spector, 2006). The sexual dimorphism of the digit ratio occurs across several vertebrates (Brown, Finn, & Breedlove, 2002; Burley & Foster, 2004). This is presumably because of a group of homologous Hox genes found across vertebrates involved in the development of digits and of the urogenital system (Kondo,

Zákány, Innis, & Duboule, 1997; Peichel, Prabhakaran, & Voght, 1997). The influence of prenatal testosterone on digit ratio has also been experimentally demonstrated in other vertebrates (Romano, Rubolini, Martinelli, Alquati, & Saino, 2005; Talarovičová, Kršková, & Blažeková, 2009).

2D:4D has been associated with a wide variety of sexually differentiated phenomena such as aggression (Bailey & Hurd, 2005), sexual orientation (Hall & Love, 2003; Manning, Churchill, & Peters, 2007; Williams et al., 2000), athletic ability (Manning & Hill, 2009; Manning & Taylor, 2001), sensation seeking (Fink, Neave, Laughton, & Manning, 2006), and behavior in economic games (Van den Bergh & Dewitte, 2006), albeit approximately one fourth of digit ratio studies published over the last decade have yielded mixed or negative findings (Voracek & Loibl, 2009; note that this bibliometric analysis does not include unpublished papers, which are more likely to include null results than published ones because of publication bias). 2D:4D has also been linked to one's propensity to engage in financially risky decisions. Coates, Gurnell, and Rustichini (2009) reported that 2D:4D was negatively correlated with trading performance in a sample of 44 male high-frequency financial traders in London. The researchers attribute this finding in part to the effects of prenatal androgens on risk preferences. Coates and Page (2009) found support for the association between digit ratio and risk-taking by demonstrating that 2D:4D was negatively correlated with the amount of trading-related risk taken by male financial traders. Further, Sapienza et al. (2009) found that low 2D:4D MBA male and female students were more likely to select risky careers in finance after graduation. Moreover, Dreber and Hoffman (2007) established that 2D:4D was negatively correlated with financial risk-taking propensity in an

ethnically homogeneous sample of men and women in Sweden. However, they did not find a significant correlation between 2D:4D and financial risk-taking in an ethnically heterogeneous sample in Chicago. Similarly, Apicella et al. (2008) reported that 2D:4D was not significantly correlated with financial risk-taking in an ethnically heterogeneous sample of male Harvard students. Additionally, Sapienza et al. (2009) found a weak, nonsignificant negative correlation between 2D:4D and financial risk-taking in an ethnically heterogeneous sample of University of Chicago MBA students. Given that digit length ratios vary between ethnic groups (Manning et al., 2007; Manning & Fink, 2008; Manning, Stewart, Bundred, & Trivers, 2004), racial heterogeneity may have nullified any potential significant 2D:4D effects on financial risk-taking in both the Apicella et al. (2008) and Sapienza et al. (2009) studies. Stenstrom, Saad, Nepomuceno, and Mendenhall (2011) investigated the potential confounding effect of ethnic heterogeneity by examining the associations between digit ratios and risk-taking behavior in an ethnically homogeneous (Whites) and an ethnically heterogeneous sample (full sample). They used Weber et al.'s (2002) scale of domain-specific risk-taking propensity, which assesses one's likelihood of engaging in risky behavior across financial, recreational, social, ethnical, and health domains. They found that low digit ratio was associated with greater financial, recreational, and social risk-taking behavior among White males. In the ethnically heterogenous male sample, there was only one significant correlation, with digit ratio being negatively correlated with financial risk-taking. They found no significant associations in either female subsample (ethnically homogeneous or heterogeneous). Thus, they obtained a great number of significant correlations between digit ratio and various types of risk-taking behavior when they accounted for ethnic

heterogeneity. On the whole, the literature suggests that 2D:4D, an indicator of prenatal testosterone exposure, may be predictive of financial risk-taking propensity, and that future digit ratio research on risk-taking and PG should account for ethnic heterogeneity.

A second purported marker of androgenisation is facial masculinity. Because masculine facial features such as prominent brow ridges and lower jaw are thought to develop under the influence of pubertal testosterone, facial masculinity is construed as a marker of testosterone levels during pubertal sexual development (Johnston, Hagel, Franklin, Fink, & Grammer, 2001). Apicella et al. (2008) found that facial masculinity was positively correlated to financial risk-taking propensity. Thus, it appears that testosterone levels during critical periods of sexual development (i.e., in utero and during puberty) can influence one's propensity to engage in financially risky behaviors in adulthood. In the ensuing section, future research avenues investigating the relationship between testosterone, financial risk-taking, and PG are proposed.

Future Research Directions

Future research exploring the link between testosterone and PG is clearly warranted given the paucity of research directly addressing this connection. Overall, the literature reviewed herein suggests that testosterone may have both organizational and activational effects on financial risk-taking proclivities. Given that (1) testosterone, 2D:4D, and facial masculinity are sometimes predictive of financial risk-taking, (2) PG is strongly associated with financial risk-taking, and (3) PG shares a common etiology with other impulsivity- related pathologies that have been linked to testosterone, it is possible that testosterone, 2D:4D, and facial masculinity are predictive of one's susceptibility to

succumbing to PG. The relationship between markers of androgenization and PG could be tested directly in future research by comparing 2D:4D and/or facial masculinity between a group of pathological gamblers and a group of healthy individuals. Research of this nature could lead to more accurate and practical methods of identifying individuals who are highly susceptible to PG.

An issue with digit ratio research is that some studies use both left- and right-hand digit ratios as separate measures in analyses (Dreber & Hoffman, 2007), others average out left-hand and right-hand digit ratios (Sapienza et al., 2009), while others use just right-hand ratios (Coates, Gurnell, & Rustichini, 2009; Coates & Page, 2009). Typically, right-hand digit ratios tend to be more sexually differentiated than left-hand ratios (Loehlin, Medland, & Martin, 2009; Manning et al., 2007; Voracek, Tran, & Dressler, 2010; Williams et al., 2000). Because running analyses using both left- and right-hand digit ratios entail a greater likelihood of Type I errors (by doubling the number of analyses), it might be advisable to focus only on right-hand digits in future research. Further, the fact that digit ratio and facial masculinity are proxies of androgenization may lead to a good deal of statistical noise and may therefore only proffer rough approximations of PG behavior. Therefore, it is important to have realistic expectations with regards to the power of testosterone, proxies of androgenization, and other biological markers (e.g., gene polymorphisms) in terms of predicting PG susceptibility. That said, some digit ratio studies have reported a relatively strong correlation between 2D:4D and risky behavior (e.g., Coates & Page, r = -.43; Coates et al., 2009, r = -.48), which underscores the potential for biological markers such as digit ratio to predict behavior such as PG.

Future studies could also investigate if other proxies of androgenization are predictive of PG. For instance, performance on a social sensitivity test has recently been linked to financial risk preferences (Sapienza et al., 2009). Prenatal testosterone exposure is hypothesized to influence one's ability to recognize and empathize with others' emotions (Baron-Cohen, Knickmeyer, & Belmonte, 2005). The "Reading the Mind in the Eyes" test by Baron-Cohen, Wheelwright, Hill, Raste, and Plumb (2001) assesses one's ability to identify the feelings expressed in over 30 pairs of eyes, with lower scores presumably being associated with greater prenatal testosterone exposure. Sapienza et al. (2009) reported that scores on the Baron-Cohen social sensitivity test were negatively correlated with financial risk-taking propensity. In other words, this purported proxy of greater prenatal testosterone exposure was associated with greater financial risk-taking.

Another potentially fruitful research avenue could be to focus on identifying precisely which gene polymorphisms may be involved in testosterone's impact on PG. For example, the androgen receptor gene has been identified as playing a significant role in androgenic function. More precisely, polymorphisms in the androgen receptor gene are thought to be involved in an individual's physiological sensitivity to testosterone (Manning et al., 2003), and have been linked to an increased risk of prostate cancer (Brooke & Bevan, 2009; Montgomery, Price, & Figg, 2001). Androgen receptor gene polymorphisms have also been shown to influence how men's testosterone levels respond to an interaction with a flirtatious young woman (Roney, Simmons, & Lukaszewski, 2010). In addition, the estrogen receptor gene may also play a significant role in androgenic function. Raskin et al. (2009) and Sato et al. (2004) have found evidence suggesting that the estrogen receptor gene influences sexual differentiation through

indirect androgenic processes. Thus, whether or not polymorphisms of the androgen receptor gene and those of the estrogen receptor gene have an impact on financial risk-taking proclivities and PG susceptibility should be investigated. Finally, future studies could explore gene-environment interactions and epigenetic influences that might augment one's likelihood of succumbing to PG. Overall, a better understanding of the neuropsychopathology of PG would likely contribute to the development of more effective treatments.

Discussion

The current review paper is part of a larger research stream that has demonstrated the deleterious effects of testosterone in particular contexts. For example, testosterone is in part responsible for the fact that men have a shorter life span than women worldwide. Specifically, testosterone has a negative effect on immunocompetence and it causes men to engage in greater levels of risk-taking and intrasexual violence, resulting in higher probabilities of mortality from parasitic disease, accidental death, and homicide (Badcock, 2000, chapter 1; Owens, 2002). Hence, the costs of testosterone loom large on men both biologically and behaviorally. That said, to the extent that testosterone is part of an evolved endocrinological system that yields net reproductive benefits to men early on in their reproductive windows (via sexual selection), one would expect the hormone to be a central driver of male-based behaviors. Notwithstanding this fact, testosterone can at times potentially yield negative outcomes, as per those posited in the current paper.

It should be acknowledged that different types of PG (e.g., table games vs. slot machines) are likely to have different underlying neurobiological pathways (van Holst et

al., 2010). Therefore, it is possible that certain types of gambling are more likely to be related to testosterone than others. For instance, male and female pathological gamblers tend to prefer different forms of gambling. Specifically, male pathological gamblers are more likely to succumb to the allure of table games such as blackjack or poker, while female gamblers are more likely to have problems with slot machines or bingo (Grant & Kim, 2002; Potenza et al., 2001). Hence, the types of gambling preferred by men may be more likely to have the hypothesized androgen-related etiology than the forms of gambling preferred by women. Additionally, it should be noted that PG is a highly complex pathology in which several neural pathways, gene polymorphisms, and environmental factors are involved. The current paper has delimited the issue by focusing mainly on testosterone, thereby oversimplifying the etiology of PG. Likewise, testosterone is a complex hormone that not only predicts behavior but also responds to it (Mazur & Booth, 1998). For instance, deleterious health and lifestyle choices and illnesses have been linked to subsequent decreases in testosterone levels (Travison, Araujo, Kupelian, O'Donnell, & McKinlay, 2007; Woolf, Hamill, McDonald, Lee, & Kelly, 1985). Testosterone therefore serves as both a precursor of the likelihood of engaging in deleterious behaviors as well as an outcome.

Lastly, the merging of biology and economic decision-making is a nascent field. Given that some of the recent studies cited in the current paper have produced mixed effects, further research is warranted to tease out precisely which conditions and sample characteristics are most suitable for yielding theoretically sound and empirically robust effects. For instance, testosterone administration had no effects on ultimatum game behavior in one sample of women (Zethraeus et al., 2009), it induced more generous

behavior in another sample of women (Eisenegger et al., 2010b), yet it promoted less generous behavior in a sample of men (Zak et al., 2009). Given that the activational effects of testosterone in adulthood depend on the organizational influence of testosterone exposure during prenatal development (Mazur & Booth, 1998), further research is required to better understand the differential effects of T on economic behavior in men and women. The literature on genetics also carries certain limitations. For instance, Ioannidis, Ntzani, Trikalinos, and Contopoulos-Ioannidis (2001) report that the effect sizes for studies reporting novel genetic associations tend to be much larger than that of replication studies. Hence, future evidence linking genes involved in dopaminergic and serotonergic function to financial risk-taking and PG is necessary before any firm conclusions can be drawn regarding these associations. It will be interesting to see which findings relating neurogenetics and testosterone to risk-taking and PG will hold up to further empirical scrutiny. Nonetheless, our review of the extant literature suggests that testosterone, digit ratio, and facial masculinity may be predictors of PG susceptibility given that highly androgenized individuals tend to display a greater appetite for financial risk, and are more likely to succumb to other impulsivity-related pathologies.

TRANSITION BETWEEN PAPERS 1 AND 2

In essence, our review of the literature on testosterone, financial risk-taking, and pathological gambling in paper 1 suggests that, although much of the research linking testosterone to risk-taking is mixed, circulating testosterone levels, digit length ratio, and facial masculinity may be predictors of PG susceptibility. Furthermore, paper 1 indicates that the great majority of this literature focuses exclusively on financial risk-taking, thereby neglecting testosterone's influences on other types of risk-taking. Could highly androgenized individuals engage more in certain forms of risk-taking but not others? In the following section, I present paper 2 titled "Testosterone and domain-specific risk: Digit ratios (2D:4D and *rel*2) as predictors of recreational, financial, and social risk-taking behaviors" published in *Personality and Individual Differences* (2011). In this paper, Gad Saad, Marcelo Nepomuceno, Zack Mendenhall, and I examine how testosterone might influence various types of risk-taking such as recreational, social, financial, health-related, and ethical.

PAPER 2: TESTOSTERONE AND DOMAIN-SPECIFIC RISK: DIGIT RATIOS (2D:4D AND *REL*2) AS PREDICTORS OF RECREATIONAL, FINANCIAL, AND SOCIAL RISK-TAKING BEHAVIORS

Abstract

Prenatal testosterone has important effects on brain organization and future behavior. The second-to-fourth digit length ratio (2D:4D), a proxy of prenatal testosterone exposure, has been linked to a wide variety of sexually differentiated dispositions and behaviors. We examine the relationship between digit length ratios (2D:4D and *rel*2, the length of the second finger relative to the sum of the lengths of all four fingers) and risk-taking behaviors across five domains: financial, social, recreational, ethical, and health. In a sub-sample of male Caucasians (ethnically homogeneous), lower *rel*2 was predictive of greater financial, social, and recreational risk-taking, whereas lower 2D:4D was predictive of greater risk-taking in two domains (social and recreational). In the full male sub-sample (ethnically heterogeneous), the only significant correlation was a negative association between 2D:4D and financial risk. A composite measure of risk-taking across all five domains revealed that both *rel*2 and 2D:4D were negatively correlated with overall risk-taking in both male sub-samples. No significant correlations were found in the female subsamples. Finally, men were more risk-seeking than women across all five contexts.

Introduction

While individuals vary a great deal in their tendency to take risks, men tend to engage in more risky behavior than women across a variety of contexts (Byrnes, Miller, & Schafer, 1999; Wang, Kruger, & Wilke, 2009). Male financial investors, for instance, tend to weigh risk attributes less heavily and recommend riskier choices when building financial portfolios compared to their female counterparts (Olsen & Cox, 2001). Likewise, men are more risk-seeking in gambling tasks (van Leijenhorst, Westenberg, & Crone, 2008) and are more likely to succumb to pathological gambling (Saad, 2007a, chap. 6; Volberg, Abbott, Ronnberg, & Munck, 2001). Furthermore, greater physical risk-taking among men leads to higher probabilities of mortality from motor vehicle accidents and homicide (Owens, 2002). Men's greater penchant for risk-taking has sparked an interest in exploring the role that testosterone plays in risky behavior. In the current paper, we examine the association between a proxy of prenatal testosterone exposure (digit length ratio) and risk-taking behavior across several domains.

A few studies have investigated the link between circulating testosterone and risk-taking propensity. For instance, testosterone levels have been linked to risky antisocial and delinquent behaviors in adolescent boys (Rowe, Maughan, Worthman, Costello, & Angold, 2004; Vermeersch, T'Sjoen, Kaufman, & Vincke, 2008), and health-related risk taking in adult males (smoking, having multiple sex partners, drug use, and alcohol abuse; Booth, Johnson, & Granger, 1999). A popular vein of inquiry in the testosterone and risk-taking area has been to examine risk-taking within the financial realm. Coates and Herbert (2008) showed that testosterone levels of male financial traders measured in the morning were predictive of their profitability that day. White, Thornhill, and

Hampson (2006) demonstrated that circulating testosterone was positively related to new venture creation among males, and the effect was partially mediated by risk-taking propensity. In a sample of male students, Apicella et al. (2008) found that testosterone levels correlated positively with financial risk-taking preferences in a monetary investment task. Similarly, in a female sample, van Honk et al. (2004) found that a sublingual administration of testosterone elicited riskier and less advantageous financial choices in the Iowa Gambling Task than did a placebo. Recently, Sapienza, Zingales, and Maestripieri (2009) showed that MBA students with higher testosterone levels were more likely to choose a career in finance than a career in a less risky field after graduation. They also reported that financial risk-taking preferences were positively correlated with testosterone levels among female students, but not among males. Zethraeus et al. (2009) found no significant effects of testosterone treatments over four weeks on risk aversion in a sample of postmenopausal women. On the whole, the literature suggests a positive relationship between circulating testosterone levels and risk-taking proclivity, though some studies have yielded either mixed or null effects.

Whereas the direct measurement and manipulation of circulating testosterone has generated valuable insights regarding the 'activational' role of testosterone on risk-taking, other studies have focused on developmental, or 'organizational' effects. Testosterone plays a critical organizational role in masculinization both prenatally and at puberty. During puberty, testosterone exposure is essential for the suite of masculinizing effects associated with this developmental stage (Archer, 2006; Mazur & Booth, 1998). Prenatal testosterone exposure influences fetal brain organization and future sexually differentiated behaviors (Archer, 2006; Auyeung et al., 2009; Udry, 2000). This exposure

also seems 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). As a result, the second-to-fourth digit ratio (2D:4D) has been used as a proxy of both the exposure and sensitivity to prenatal testosterone (Manning, 2002; Manning, Bundred, Newton, & Flanagan, 2003). This association has spurred considerable interest in 2D:4D, which has been linked to an array of masculine traits including aggression (Bailey & Hurd, 2005), athletic ability (Manning & Hill, 2009), and perceived dominance (Neave, Laing, Fink, & Manning, 2003). Even among females, a lower 2D:4D tends to predict masculine behavioral traits (Brown, Finn, Cooke, & Breedlove, 2002; Clark, 2004; Paul, Kato, Hunkin, Vivekanandan, & Spector, 2006). However, some masculine proclivities appear to exhibit no robust relationship to 2D:4D (cf. Voracek, Tran, and Dressler's (2010) meta-analysis on sensation-seeking).

Of particular relevance to the current work, Schwerdtfeger, Heims, and Heer (2010) showed that 2D:4D was negatively correlated to traffic violations, suggesting that highly androgenized males engage in riskier driving behavior. Coates, Gurnell, and Rustichini (2009) found that male traders with lower 2D:4D performed better than men with higher digit ratios. The authors speculate that part of this association could stem from a greater risk-taking proclivity in low 2D:4D individuals. Coates and Page (2009) obtained evidence in support of this relationship by showing a negative correlation between 2D:4D and the level of risk taken by high frequency male traders. Further, Dreber and Hoffman (2007) showed that a lower, more masculine 2D:4D was associated with a greater preference for financial risk in an ethnically homogeneous mixed-sex sample (controlling for sex) in Sweden albeit no such effect was uncovered for a

heterogeneous mixed-sex sample in the US. Apicella et al. (2008) also found that financial risk was not significantly correlated with 2D:4D in an ethnically heterogeneous male sample. The authors conjecture that ethnic heterogeneity and the small size of their sample might have made it impossible to detect a significant digit ratio effect. Finally, Sapienza et al. (2009) did not obtain a significant correlation between 2D:4D and financial risk-taking in a mixed-sex sample of students. However, they reported that students with lower 2D:4D were significantly more likely to select a career in finance than in a less risky field. The equivocal findings reported in the three aforementioned studies may in part be due to the use of ethnically heterogeneous samples, as suggested by Apicella et al. (2008). Manning, Churchill, and Peters (2007) showed that amalgamating the data of different ethnic groups can eliminate digit ratio effects, as the correlation between sexual orientation and 2D:4D was found in certain ethnic groups but not in others. The current study addresses this issue by examining associations between digit ratios and risk-taking propensity in a large, ethnically heterogeneous sample and comparing effects among heterogeneous versus homogeneous sub-samples.

Thus far, much of the research investigating the links between digit ratio and risk-taking proclivity has focused solely on risk preferences within a financial context. Risk-taking preferences are assessed via a financially-related measure, subsequent to which the findings are generalized to all domains of risk (i.e. one index of risk is associated equally to all risk-related contexts). While this operationalization of risk preferences is consistent with the domain-general assumptions of both the expected utility framework and prospect theory (Kahneman & Tversky, 1979), more recent research suggests that risk-taking proclivity is a domain-specific phenomenon in which an individual's risk proclivities are

different across domains (Weber, Blais, & Betz, 2002). In other words, an individual may display a strong appetite for financial risk and a strong aversion to risk in other domains such as recreational activities or social situations. Accordingly, in the current study, we explore the links between the digit ratio and domain-specific instantiations of risk.

In sum, while the results are somewhat mixed, it would appear that testosterone has both organizational and activational effects on financial risk-taking. Furthermore, there is a lack of research exploring the link between digit ratios and risk-taking in other domains. The current paper examines if digit ratio is predictive of risk-taking propensity across recreational, financial, social, ethical, and health domains. We propose that lower, more masculine digit ratios are predictive of riskier behaviors across all five domains among both men and women.

Method

Participants

Four hundred and forty-nine students were recruited from classrooms at a Canadian university. Two students had broken fingers and 34 students did not complete the survey, resulting in a final sample size of 413. Participants were 53% male and were aged 17–44 years (mean = 20.9). The sample was ethnically heterogeneous, consisting of 58% Caucasian, 22% Asian, 10% Middle-Eastern, 2% Black, 2% Hispanic, and 6% other, mixed, or unspecified.

Procedure and Measures

Participants were asked to fill out a survey containing the domain-specific risk items, demographic information, and other measures that are part of a larger research project that falls outside the scope of the current paper. Risk was assessed via a domain-specific risk-taking behavior scale as described in Weber et al. (2002; see Appendix A). Each of the five domains contained 10 five-point Likert-type items (1–5) assessing one's likelihood of engaging in a given risky activity. Items include ''periodically engaging in dangerous sports (e.g. mountain climbing or sky diving)" (recreational), ''investing 10% of your annual income in a very speculative stock" (financial), ''speaking your mind about an unpopular issue at a social occasion" (social), ''shoplifting a small item (e.g. a lipstick or pen)" (ethical), and ''eating 'expired' food products that still 'look okay' " (health).

The Cronbach alphas (a measure of the reliability of a multi-item, single-construct scale) for recreational, financial, social, ethical, and health risks were all within an acceptable range (0.83, 0.69, 0.67, 0.80, and 0.68, respectively). Additionally, we created a composite score of general risk-taking that encompasses all five domains of risk by amalgamating the five indices ($\alpha = 0.87$). In terms of validity estimates, Weber et al. report that the five risk-taking subscales were moderately positively correlated with Zuckerman's (1994) four sensation-seeking subscales. The two highest correlations they obtained were between the thrill-and-adventure-seeking subscale and recreational risk-taking ($r = 0.56$), and between the disinhibition subscale and ethical risk-taking ($r = 0.53$). Recently, Loehlin, Medland, and Martin (2009) introduced a new set of measures of digit ratios that compare the length of one finger to the sum of the length of all four

fingers. For example, *rel*2 is the relative length of the index finger to all four fingers (2D/ [2D + 3D + 4D + 5D]). In a sample of 800 Australian adolescents, they found that sex differences were larger for *rel*2 than for any other digit ratio, including 2D:4D. Given these results, we included the *rel*2 measure as well as the traditional 2D:4D measure as proxies of prenatal androgen exposure in the current study. The lengths of all right-hand digits of each subject were measured directly by one of three trained experimenters using digital callipers. We focused on digit ratios of the right hand given that they tend to be more sexually differentiated than digit ratios of the left hand (Loehlin et al., 2009; Manning et al., 2007; Voracek et al., 2010).

In order to establish inter- and intra-experimenter repeatabilities, experimenters visited a separate classroom of 22 students wherein each participant was directly measured six times (twice by each of the three experimenters). Repeatabilities were assessed with intraclass correlation coefficients (ICC; two-way mixed-effects model, single-score, absolute-agreement). We measured repeatabilities for a separate sample rather than the entire study's sample because of methodological constraints. Although this is a limitation of our method, we assume that the separate sample repeatabilities adequately approximate the achieved reliabilities in the full sample since they were taken under similar conditions (time constraints) and within the same population (students). Intra-experimenter ICC's were as follows: 0.935 for $2D{:}4D_{\text{experimenter 1}}$, 0.942 for $2D{:}4D_{exp2}$, 0.899 for $2D{:}4D_{exp3}$, 0.921 for $rel2_{exp1}$, 0.921 for $rel2_{exp2}$, 0.925 for $rel2_{exp3}$. Inter-experimenter ICC was 0.818 for $2D{:}4D_{\text{trial A}}$, 0.819 for $2D{:}4D_{trB}$, 0.817 for $rel2_{trA}$, and 0.844 for $rel2_{trB}$.

Results

Table 1 displays the digit ratios (2D:4D and *rel*2) as well as the risk proclivities scores for both sexes. As expected, men exhibited riskier behaviors than women across all five domains (all p values < 0.001, one-tailed) and they had lower 2D:4D and *rel*2 compared to women (both p values = 0.001, one-tailed).

To control for the potentially confounding effects of sex and ethnic heterogeneity, we performed analyses on the following four sub-samples: male Caucasians (n = 130), female Caucasians (n = 109), all males (n = 219), and all females (n = 194). Caucasians were selected for our ethnically homogeneous analyses since they were the largest ethnic group in our sample. Pearson correlations (one-tailed) between digit ratios (2D:4D and *rel*2) and risk-taking measures across the four sub-samples are summarized in Table 2. Overall, stronger digit ratio effects were found in the ethnically homogeneous male sub-sample as compared to its ethnically heterogeneous counterpart. Specifically, among Caucasian men, *rel*2 was negatively correlated to three of the five measures of risk-taking propensity, namely recreational risk (r = -0.203, p < 0.01), financial risk (r = -0.142, p = 0.05), and social risk (r = -0.213, p < 0.01). 2D:4D was negatively correlated with recreational risk (r = -0.162, p < 0.05) and social risk (r = -0.167, p < 0.05) in this group. The composite score of risk-taking yielded a significant effect for the Caucasian male sub-sample, with overall risk-taking being significantly negatively correlated with both *rel*2 (r = -0.210, p < 0.01) and 2D:4D (r = -0.150, p < 0.05). When ethnicity is not taken into account (i.e. in the full male sub-sample), the only significant results are negative correlations between 2D:4D and financial risk (r = -0.132, p < 0.05) and overall risk (r =

-0.119, $p < 0.05$), and between *rel*2 and overall risk ($r = -0.113$, $p < 0.05$). There were no significant correlations for any of the female sub-samples, for either measure of digit ratio. Finally, one of the issues of interest is which of the digit ratios yields stronger effects. For each of the six sets of 2D:4D and *rel*2 correlations wherein at least one correlation was significant, we ran a t-test (two-tailed) to ascertain any significant differences in correlation strength (Chen & Popovich, 2002, p. 21). No significant differences emerged.

	Men ($n = 219$)		Women ($n = 194$)			
	M	SD	M	SD	*t*	*Cohen's d*
Digit ratios						
2D:4D	0.965	0.035	0.976	0.034	−3.07*	0.30
*rel*2	0.250	0.006	0.252	0.005	−3.08*	0.31
Risk-taking						
Recreational	2.971	0.836	2.710	0.818	3.19**	0.24
Financial	2.377	0.591	2.132	0.551	4.33**	0.43
Social	3.237	0.567	3.068	0.539	3.08**	0.30
Ethical	2.243	0.836	1.821	0.818	3.19**	0.62
Health	2.485	0.616	2.143	0.572	5.83**	0.58
Overall	2.663	0.448	2.375	0.397	6.86**	0.68

* $p = 0.001$.
** $p < 0.001$ (one-tailed).

Table 1: Sex differences in digit ratios and risk-taking behaviors.

Risk domain	Caucasian men		Caucasian women		Men		Women	
	(n = 130)		(n = 109)		(n = 219)		(n = 194)	
	2D:4D	*rel*2	2D:4D	*rel*2	2D:4D	*rel*2	2D:4D	*rel*2
Recreational	−0.162*	−0.203**	−0.035	0.073	−0.092	−0.070	0.056	0.125
Financial	−0.081	−0.142*	0.035	−0.038	−0.132*	−0.089	0.032	0.002
Social	−0.167*	−0.213**	−0.013	−0.049	−0.065	−0.084	−0.037	−0.081
Ethical	−0.061	−0.083	−0.061	−0.059	−0.075	−0.083	0.029	0.022
Health	−0.015	−0.049	0.057	0.039	−0.035	−0.052	0.047	0.031
Overall	−0.150*	−0.210**	−0.010	0.000	−0.119*	−0.113*	0.046	0.046

* $p \leqslant 0.05$.
** $p \leqslant 0.01$ (one-tailed).

Table 2: Correlations (Pearson r) of digit ratios (2D:4D and *rel*2) with risk-taking behaviors.

Discussion

Our results suggest that prenatal testosterone exposure has organizational effects on a man's recreational, financial, and social risk-taking propensity. Contrary to our expectations, there were no significant correlations between digit ratio and risk in the ethical and health domains among men. One explanation for this pattern of results is that, compared to ethical and health risk-taking, recreational, financial, and social risk-taking serve as more honest signals of desirable traits in men. Specifically, evolutionary theorists have hypothesized that sex differences in risk-taking stem from greater intrasexual competition for access to mating opportunities among men (Baker & Maner, 2008; Wilson & Daly, 1985). Risk-taking can therefore be a means of honest signalling to potential mates. For instance, using a domain-general measure of risk-taking (the Balloon Analogue Risk Task), Baker and Maner (2009) showed that risk-taking increased among men (but not women) when they were told that their risk-taking performance would be witnessed by a romantically available confederate of the opposite sex. Thus, risky behaviors among highly androgenized males can be indicative of traits that are both testosterone-related and highly desirable to potential mates such as ambition, confidence, financial capacity, and social dominance (Baker & Maner, 2008; Buss, 1989; Li, Bailey, Kenrick, & Linsenmeier, 2002). These desirable traits are more likely to be displayed by recreational risks (e.g. engaging in dangerous sports), financial risks (e.g. investing in a risky business), and social risks (e.g. openly disagreeing with a boss) than by health risks (e.g. eating food that may make you sick) and ethical risks (e.g. buying an illegal drug). Hence, low *rel*2 (i.e. highly androgenized) males may be engaging in greater recreational, financial, and social risk-taking as a means of honest signalling.

Unexpectedly, the digit ratio effects were solely operative for the male sub-samples. While we expected men to have higher risk preferences than women, we did not expect that prenatal T exposure would explain variance in risk among men but not among women. Theoretically speaking, we expected individual differences in risk tolerance among women to be partially explained by prenatal T exposure. Given that digit ratio has been associated with a number of masculine behaviors among women (Brown et al., 2002; Paul et al., 2006), the null effects in our female sub-samples are somewhat surprising. A possible explanation for these null effects is that women are not likely to engage in risky behaviors as a form of mating signal (cf. Baker & Maner, 2009). Males tend to prefer traits in women that signal high reproductive capacity (e.g. physical attractiveness, youth), rather than traits associated with risk-taking (Buss, 1989; Li et al., 2002). Therefore, prenatal testosterone in women might promote intrasexual competitive signalling associated with reproductive capacity instead of risky behavior.

Our findings underscore the importance of controlling for ethnicity in digit ratio research. Previous 2D:4D research on financial risk-taking preferences has tended to yield significant effects only when ethnically homogeneous samples were used (consistent with Apicella et al., 2008; Dreber & Hoffman, 2007; Sapienza et al., 2009). Our results relating to 2D:4D and financial risk do not replicate this pattern in the literature (in fact, we only find support for a correlation between financial risk and 2D:4D in the heterogeneous male sub-sample). However, the preponderance of our evidence (across domains and measures of digit ratio) suggests that controlling for ethnicity accounts for systematic variation within the data, thereby leading to a greater likelihood of uncovering effects. More precisely, we obtained a greater number of significant effects

across risk domains in the ethnically homogeneous subsample of Caucasian men as compared to the ethnically heterogeneous sub-sample of all men (seven significant correlations versus three, despite a substantial reduction in sample size in the homogeneous sub-sample; see Table 2). Nonetheless, given that the digit ratio literature as a whole (and our study in particular) has revealed a considerable number of null and/or small effects (Voracek & Loibl, 2009 found that a quarter of the studies in the last decade yielded null or mixed findings), further research is required to establish the sample characteristics and psychological constructs that are most appropriate for producing robust effects.

Recently, Voracek (2009) investigated sex differences across several digit ratios (including Loehlin et al.'s (2009) novel relative fingers length measures) across six samples totalling 801 participants. Voracek found that *rel*2 and 2D:4D were equally sexually dimorphic, a conclusion supported in our own findings (refer back to Table 1). That said, the three strongest correlations in our study emerged when *rel*2 was used, thereby lending some credence to Loehlin et al.'s (2009) new *rel*2 measure. Given the novelty of *rel*2, further research comparing the capacity of both *rel*2 and 2D:4D to predict masculinized dispositions is certainly warranted.

Whereas we have focused on the digit ratio, there are numerous other proxies of androgenisation that might be predictive of risk-taking proclivities. For example, Sapienza et al. (2009) found that performance on the Baron-Cohen, Wheelwright, Hill, Raste, and Plumb (2001) social sensitivity test, a purported proxy of prenatal androgenisation, is predictive of financial risk preferences (albeit Voracek and Dressler (2006) found no correlation between 2D:4D and Baron-Cohen et al.'s measure). Facial

masculinity (e.g. square jaw), a marker of androgenization during puberty, has also been associated with financial risk preferences (Apicella et al., 2008). Hence, future research should investigate to what extent different proxies of androgenization (digit ratio, social sensitivity, facial masculinity, and circulating testosterone) are predictive of risk-taking propensity across various contexts. Generally speaking, our study adds to the growing literature connecting testosterone to financial (Coates et al., 2009), social (Saad & Vongas, 2009; Zak et al., 2009), and recreational behaviors (Booth et al., 1999; Nepomuceno, Saad, Stenstrom, & Mendenhall, 2009).

TRANSITION BETWEEN PAPERS 2 AND 3

In paper two, we demonstrated the organizational effects of testosterone on risk-taking by showing that digit ratio is negatively correlated with recreational, social, and financial risk-taking behavior in Caucasian males. In the subsequent section, I present paper three (Stenstrom & Saad, Working Paper), titled "The effects of baby exposure on consumer risk-taking," wherein we shift our attention from organizational effects of testosterone to activational ones. In particular, Gad Saad and I investigate how risk-taking is influenced by exposure to social stimuli that purportedly elicits changes in testosterone. More precisely, we examine how exposure to baby stimuli, which has been shown to elicit changes in circulating testosterone levels, influence risk-taking. While it is well established that infantile features such as bulging cheeks and large eyes are perceived as cute and elicit care-taking motives in adults, little is known regarding how exposure to baby stimuli impacts risk-taking. In the following paper, we examine how exposure to baby photos and sounds (laughing and crying) influences risk-taking. Further, we test if parents and non-parents respond differently to baby exposure.

PAPER 3: THE EFFECTS OF BABY EXPOSURE ON CONSUMER RISK-TAKING

Introduction

Imagine that you are walking down the Vegas strip on your way to a casino, when you notice a cute baby in a stroller smiling at her father. You think to yourself "what a cute baby" and stop to say hello. After a few playful moments spent with the baby, you continue on your way. Suddenly, you realize that your desire to gamble has waned and you decide to attend a show instead. The latter anecdote describes the primary question we address in the current work, namely whether or not one's desire to engage in various forms of risk-taking (e.g., gambling) is influenced by exposure to babies.

Whether it's gambling in Vegas, investing in stocks, or drinking too much alcohol, consumers often partake in risky behavior. Accordingly, understanding which factors drive risk-taking and how marketing and public policy managers can curb or promote these behaviors is of great practical significance. While it is well established that infantile features such as large eyes and bulging cheeks are perceived as cute and elicit care-taking responses in adults (Alley, 1981, 1983a; Glocker et al., 2009a, 2009b; Lorenz, 1943, 1971), only one study by Fischer and Hills (2012) has explored how exposure to babies might impact risk-taking. They asked undergraduate students to complete a series of financial decision-making tasks wherein they were hypothetically being paired with an infant, a male adult, or a female adult. For each task, participants were shown a picture of a hypothetical partner and were instructed to imagine sharing their earnings with him/her. Fischer and Hills found that women (but not men) engaged in less risk-taking when hypothetically grouped with an infant compared to when

hypothetically grouped with a male or female adult or when alone. We build on this work by investigating how exposure to different types of baby-related stimuli (hereafter referred to as baby exposure) influences individual-level risk-taking propensity in both men and women. Specifically, we examine how exposure to baby photos and sounds (laughing and crying) impacts risk-taking. Further, we examine if baby exposure effects on risk-taking are influenced by an individual's parental status and his/her biological sex.

Traditionally many psychologists and economists alike have construed individuals' risk-taking proclivities as a manifestation of their largely non-pliable personalities. Some scholars have questioned this assumption including behavioral decision theorists who have shown that people's risk preferences change as a function of whether they are facing gains or losses (Kahneman & Tversky, 1979). The current work offers additional support of the malleability of such preferences by showing that risk-taking tendencies can be altered via the exposure to a set of ecologically-relevant triggers.

The remainder of the paper is organized as follows. In the ensuing section, we present our conceptual development wherein we discuss the extant literature on baby exposure effects. Next, we present study 1 in which we explore the impact of exposure to baby photos on risk-taking propensity. Subsequently, in study 2, we examine the effects of exposure to baby laughs and cries on risk-taking. Lastly, we conclude with a general discussion wherein we consider the theoretical and practical implications of our research.

Conceptual Development

Charles Darwin (1872) proposed that babies possess unique features that promote parental care, thereby increasing their survivability. Along those lines, ethologist Konrad

Lorenz, a co-winner of the 1973 Nobel Prize for Physiology or Medicine, argued that infantile traits such as a large head, round face, high forehead, bulging cheeks, and large eyes (called 'Kindchenschema,' or baby schema) are viewed as cute and elicit care-taking motives in adults (1943, 1971). Researchers have since provided empirical evidence supporting the notion that babies are perceived as cuter (Alley, 1981, 1983a; Brooks & Hochberg, 1960) and elicit greater care-taking and protective motives than older children and adults (Alley, 1983b, 1983c). Furthermore, baby faces with artificially enhanced infantile characteristics (e.g., round face) are perceived as being cuter (Glocker et al., 2009a) and elicit greater care-taking motives compared to those with artificially reduced infantile features (narrow face) and to non-manipulated ones (Glocker et al., 2009b). From an evolutionary perspective, psychological mechanisms that promote care-taking motives in response to viewing infantile features are adaptive since they augment the survivability of offspring (Eibl-Eibesfeldt, 1989; Lobmaier, Sprengelmeyer, Wiffen, & Perrett, 2010). Of note, there is evidence that this baby effect is operative in a cross-species setting, namely humans evaluate animals such as dogs and cats possessing infant-like features more favourably (Archer & Monton, 2011; Borgi & Cirulli, 2013; Fullard & Reiling, 1976). Moreover, viewing animals with infantile features leads to more careful behavior in fine-motor dexterity tasks consisting of playing a children's surgical operation game (Nittono, Fukushima, Yano, & Moriya, 2012; Sherman, Haidt, & Coan, 2009). Viewing a cute animal also increases the likelihood that an individual will participate in a survey-based study (Bellfield et al., 2011). Further, infantile features can also be perceived as cute in abstract geometric forms (Cho, 2012), and products such as

toys (Hinde & Bearden, 1985) and cars (Miesler, Leder, & Herrmann, 2011) with infant-like features are perceived more favourably as well.

Although the effects of baby exposure on cuteness perceptions and care-taking are well established, their effects on risk-taking remain understudied. How might baby exposure influence risk-taking in men and women? Prior to answering this question, let us first consider how men respond hormonally to becoming a father. Our theoretical framework draws from a biological theory regarding testosterone called the Challenge Hypothesis (Archer, 2006). This theory originally stems from an explanation regarding the links between testosterone and reproductive, aggressive, and parental behavior in male birds (Wingfield, Hegner, Dufty, & Ball, 1990). At the beginning of the breeding season, testosterone levels rise in order to promote mate-seeking behavior. When male birds are challenged or threatened by other males in mating-related contexts, testosterone levels rise, thereby promoting displays of intra-sexual aggressive dominance. Once male birds become parents and must care for their offspring, their testosterone levels decrease dramatically. When these parental birds are experimentally injected with testosterone, they suddenly become terribly negligent parents, forgoing their care-taking behavior in lieu of mate-seeking and displays of intra-sexual aggressive behavior. Essentially, a reduction in testosterone associated with becoming a new parent promotes care-taking of offspring while reducing aggressive behavior and mate-seeking in birds. Archer (2006) argues that the Challenge Hypothesis can be applied to humans to explain the links between testosterone, aggressive intra-sexual competition and response to threats, mating, and parental behavior. There is a large body of evidence supporting the notion that the Challenge Hypothesis applies to humans. Of note, new fathers experience a decrease in

testosterone during the first few months of becoming a parent (Berg & Wynne-Edwards, 2001; Gettler, McDade, Feranil, & Kuzawa, 2011; Gray, 2011; Storey, Walsh, Quinton, & Wynne-Edwards, 2000), and fathers have lower testosterone levels than non-parents (Berg & Wynne-Edwards, 2001; Burnham et al., 2003; Fleming, Corter, Stallings, & Steiner, 2002; Gray, Kahlenberg, Barrett, Lipson, & Ellison, 2002; Gray, Yang, & Pope, 2006). Further, men with high testosterone levels responded to infant cries with lower sympathy towards the infant than men with low testosterone (Fleming et al., 2002). Moreover, fathers who report spending at least three hours of daily child care have lower testosterone levels than fathers who do not participate in child care (Gettler, McDade, Feranil, & Kuzawa, 2011). Hence, fatherhood is associated with lower testosterone levels.

Also consistent with the Challenge Hypothesis, men's testosterone levels and risk-taking increase in response to a perceived mating opportunity. For instance, men tend to engage in greater risk-taking behaviors after viewing photos of attractive women (Baker & Maner, 2008), while in the presence of an attractive woman (Ronay & Von Hippel, 2010), and while purportedly being watched by a single woman who was interested in meeting a new romantic partner (Baker & Maner, 2009). On a related note, exposure to sex cues also leads to greater impulsivity in men. Specifically, men discount the future more after viewing photos of attractive female faces (Wilson & Daly, 2004) and after viewing full-body photos of female models dressed in sexy outfits (Van den Bergh, Dewitte, & Warlop, 2008). Moreover, the effect of the presence of an attractive woman on risk-taking is mediated by testosterone levels (Ronay & Von Hippel, 2010). Hence, male risk-taking appears to be a sexual display strategy that is mediated by

testosterone. Consistent with this reasoning, several studies have found a positive relationship between risk-taking and testosterone, both at the activational level via circulating testosterone (Apicella et al., 2008; Apicella, Dreber, & Mollerstrom, 2014; Sapienza, Zingales, & Maestripieri, 2009) and at the organizational level via proxies of prenatal (Coates & Page, 2009; Dreber & Hoffman, 2007; Sapienza et al., 2009; Stenstrom, Saad, Nepomuceno, & Mendenhall, 2011) and pubertal (Apicella et al., 2008) testosterone exposure (see Stenstrom & Saad, 2011, for a review). Given that fatherhood is associated with a reduction in aggressive behavior, mate-seeking behavior, and testosterone levels (Archer, 2006), and that low testosterone is associated with lesser risk-taking (Apicella et al., 2008), we would expect that becoming a father would lead to lower risk-taking via a decrease in testosterone levels. Congruent with this notion, Wang, Kruger, and Wilke (2009) found that parents took less competitive risks than non-parents. Furthermore, parents perceive a potential antagonist as being more formidable than do non-parents (Fessler, Holbrook, Pollack, & Hahn-Holbrook, 2014), which suggests that parents are more risk-aversive than non-parents. On the whole, there is substantial empirical evidence indicating that fatherhood leads to a decrease in testosterone (Archer, 2006), and there is one study suggesting that parenthood leads to lesser risk-taking (Wang et al., 2009).

Does the effect of parenthood on testosterone and risk-taking also apply to women? In his 2006 review, John Archer noted that, while there was some research suggesting that the Challenge Hypothesis applies equally to women (e.g., Bateup, Booth, Shirtcliff, & Granger, 2002), there was insufficient evidence to arrive to any definitive conclusions regarding this matter. However, additional evidence has since surfaced

suggesting that the Challenge Hypothesis is indeed operative for women. Notably, there is research associating intra-sexual competitive challenges with increases in testosterone among women (Edwards, Wetzel, & Wyner, 2006; Oliveira, Gouveia, & Oliveira, 2009) and one study linking motherhood to a decrease in testosterone (Kuzawa et al., 2010). Given the substantial evidence linking testosterone to risk-taking in women (van Honk et al., 2004), a decrease in testosterone as a result of parenthood would likely lead to lesser risk-taking among women. Moreover, Wang et al. (2009) showed that parents engaged in less competition-related risks than non-parents in a sample consisting of both male and female college students. Furthermore, from an evolutionary standpoint, to engage in lesser risk-taking once one becomes a new parent would be adaptive for both sexes. Essentially, fathers and mothers avoiding unnecessary risks is beneficial for the baby's survival prospects because it not only reduces potential direct harm to the baby (since babies tend to remain in close proximity to their parents) but also reduces potential harm to the parent, which could ultimately be detrimental to the baby. Hence, it would be adaptive for parenthood to lead to a decrease in risk-taking in both men and women.

In the current work, we explore if merely being exposed to baby stimuli might influence risk-taking in a manner akin to becoming a new parent. We hope to build on prior baby effects research in three substantial ways. First, while Fischer and Hills (2012) found that cooperative risk-taking was reduced in women when they were paired with infants, we hope to show that individual-level risk-taking is influenced by merely being exposed to baby photos. In Fischer and Hills' (2012) study, they asked undergraduate students to partake in a series of hypothetical cooperative financial risk-taking tasks (the Social Balloon Analogue Risk Task). In each task, participants were

asked to imagine sharing their financial earnings with an adult male, an adult female, an infant (aged 0 to 2 years), or with no one. During each task, a photo of the hypothetical partner was presented in the upper right corner of the computer screen. Women (but not men) took less cooperative risks when grouped with an infant compared to when grouped with an adult and to when not grouped with anyone. Thus, it seems that viewing photos of infants and hypothetically sharing one's earnings with infants leads to less risk-taking in female students but not in male students. However, it remains unclear if the women in this study were less risky because they were merely exposed to photos of infants, or because they were hypothetically grouped with an infant in a cooperative financial task. In the current research, we focus on individual-level decision-making by examining how merely exposing individuals to baby stimuli will influence risk-taking. We hypothesize that mere exposure to baby photos will elicit a decline in risk-taking (H1). Given that the Challenge Hypothesis seems to apply to both sexes (Bateup et al., 2002; Edwards et al., 2006; Oliveira et al., 2009; Kuzawa et al., 2010), and that parenthood leads to lesser risk-taking in both sexes (Wang et al., 2009), we expect that baby exposure effects will influence men and women similarly.

The second way in which we hope to contribute to the baby effects literature is by considering the potential role of parental status (i.e., parents vs. non-parents). All prior studies investigating baby effects on care-taking motives (Alley, 1983b, 1983c; Glocker et al., 2009b) and the one study looking at baby effects on cooperative risk-taking (Fischer & Hills, 2012) have used samples consisting of undergraduate students, which are likely to consist primarily of non-parents. We can fathom two feasible ways in which parents might respond differently to baby exposure than non-parents. On the one hand,

parents tend to have greater experience with caring for infants than do non-parents. This experience in child care may render parents more sensitive and responsive to baby cues. In fact, experienced fathers (i.e., with multiple children) report a greater need to respond to baby cries than first-time fathers (Fleming et al., 2002). Furthermore, mothers tend to be more responsive to infant smells than non-mothers (Fleming et al., 1993). Since parental experience seems to promote responsiveness to baby stimuli, we might expect the effects of baby exposure on risk-taking to be more pronounced among parents than non-parents. Accordingly, baby exposure may lead to even lesser risk-taking in parents than in non-parents. On the other hand, parents have their own children to care for, and have finite resources with which to care for them. Parents may feel challenged or threatened by the presence of unfamiliar babies because any care-taking of unfamiliar babies by parents would reallocate parental investment, a limited resource, away from their own offspring. It is possible that a parental investment challenge of this nature might elicit an increase in testosterone much like a competitive challenge elicits a testosterone increase in men (Archer, 2006) and women (Bateup et al., 2002; Edwards et al., 2006; Oliveira et al., 2009). Thus, we might expect that parents perceive an encounter with unfamiliar babies as a potential parental investment challenge, thereby eliciting an increase in testosterone and leading to an increase in risk-taking. Hence, while we expect baby exposure to lead to lesser risk-taking in non-parents, it is possible that baby exposure elicits greater risk-taking in parents due to a parental investment challenge. Therefore, in the current work, we will explore if parents and non-parents respond differently to baby exposure in terms of risky behavior.

Third, we hope to add to previous baby effects research by exploring how different communication modalities might influence risk-taking differently. In particular, we examine if risk-taking is not only influenced by baby photos but also by two distinct baby sounds of differing emotional valence, namely crying and laughing. From an evolutionary perspective, infant crying serves as a reliable signal of need for care and as such it promotes parental care-taking (Murray, 1979; Zeifman, 2001). Infant crying has evolved in conjunction with other communication modalities such as vision (e.g., infantile facial features) and olfaction (e.g., baby smells and pheromones that also elicit parental care). The advantages of auditory signals are that they can elicit parental care more effectively in the dark or while parents are sleeping compared to visual signals, and can do so from longer distances compared to olfactory signals (Gerhardt, 1983; Zeifman, 2001). Although no research thus far has examined how baby cries influence risk-taking, some work has linked baby cries to changes in testosterone levels. Consistent with the Challenge Hypothesis, listening to baby cries was associated with a decrease in testosterone in adult males when they were given a chance to engage in care-taking with a crying baby doll (van Anders, Tolman, & Volling, 2012). Conversely, when men's exposure to baby cries was not associated with any care-taking, testosterone levels increased (Fleming et al., 2002; Storey et al., 2000; van Anders et al., 2012). As stipulated in an extension of the Challenge Hypothesis called the Steroid/Peptide Theory of Social Bonds, infant crying in the absence of nurturance elicits an increase in testosterone because it might serve as a cue for physical danger or other associated threats. Hence, baby cries without a nurturing context trigger a testosterone-inducing infant defense mechanism akin to a testosterone-increasing competitive challenge (van

Anders, Goldey, & Kuo, 2011; van Anders et al., 2012). Given that baby cries in the absence of nurturance trigger increases in testosterone, and that testosterone is associated with risk-taking, we hypothesise that baby cries (in the absence of nurturance) will lead to greater risk-taking (H2).

While infant crying has evolved to garner parental care by signaling needs (Zeifman, 2001), infant laughter has evolved as a means for eliciting parental care by promoting parental proximity, social interactions, loving feelings, care-taking, and parent-infant attachment (Bowlby, 1982; Gervais & Wilson, 2005; Riem et al., 2012). To date, no research has explored how infant laughter affects testosterone or risk-taking. However, as baby laughter serves as a means for promoting parental care-taking, we hypothesize that baby laughs will lead to lesser risk-taking (H3), presumably via a decrease in testosterone.

Whereas the different communication modalities (visual vs. auditory) and emotional valences (laughter vs. crying) of infant communication are very distinct in nature, no research thus far has investigated how adults might respond differently to them. To address this gap in the literature, we examine how risk-taking is influenced by exposure to baby photos in study 1 (H1), and explore how risk-taking is affected by baby cries (H2) and laughter (H3) in study 2. In addition, we explore if baby exposure influences risk-taking differently in parents and in non-parents in both studies 1 and 2. In order to ensure that the samples in both studies 1 and 2 contain a substantial proportion of parents, we draw our samples from national online panels of individuals aged 18 to 40 years old. In the following section, we present study 1 wherein we investigate the effects

of baby photo exposure on risk-taking and the potential moderating role of parental status.

Study 1

Method

Study 1 consisted of a 2 (baby exposure: absent, present) x 2 (parental status: non-parents, parents) between-subjects design. Two hundred and twenty seven adults were recruited from a national (US) online panel by Qualtrics Panels and were awarded $1 for completing the survey. The online survey included one of two baby exposure manipulations (present or absent), a 30-item risk-taking scale (Blais & Weber, 2006; see appendix B), a parental status question, other demographic questions, and additional measures that fall outside of the scope of this paper.

Participants were randomly assigned to one of two baby photo exposure conditions. In the baby present condition, participants were told that Yum-Yums, a Canadian baby food company, required their help to select the winner of a consumer photo contest (see Appendix C). Although Yum-Yums is a fictitious company created for this experiment, the company description that participants were asked to read implied that it was a real company. They were told that consumers were asked to send in three photos of their baby, and that the winner of the contest would be featured in the next Yum-Yums baby ad campaign. Participants were asked to examine fifteen baby photos carefully (three photos for each of the five contestants). For each of the five sets of three photos, participants were asked to rate the cuteness of each baby on a scale ranging from 1 to 9 (1 = not at all cute, 9 = extremely cute), and then to describe the cutest features of

the baby (open ended question). The goal of these questions was to encourage participants to examine the photos carefully, thereby maximizing the priming effects of the baby exposure. The five babies were from diverse ethnic backgrounds. In the baby absent condition, the task was identical to that of the baby condition except that participants were asked to examine five sets of 3 photos of landscapes (cities, mountains, and/or lakes) as part of a photo contest run by Tourism Canada (see Appendix D). Accordingly, in this condition, the two questions for each of the five sets of three photos related to the beauty of landscapes rather than the cuteness of babies. More precisely, participants were asked to rate the beauty of the landscapes on a scale of 1-9 (1 = not at all beautiful, 9 = extremely beautiful), and then to describe the most beautiful features of the landscapes in an open ended question.

We incorporated two quality-control techniques to remove bad responses. First, we measured the time taken to complete the survey and excluded respondents who skipped through the survey too quickly to have adequately read the questions or so slowly that the effects of our priming manipulation were likely to have worn off. Given the length of the survey, we estimated that to read and answer the survey questions should have taken no less than 6 minutes and no more than 30 minutes. Therefore, we removed 27 respondents who did not complete the survey within this time range. Second, we screened out respondents who did not exert the requisite cognitive effort for the open-ended question (list the cutest/most beautiful features of the baby/landscape). Specifically, we removed 25 individuals who did not describe at least one cute or beautiful feature in the photos, yielding a final sample of 175 participants. They were 54% female, 56% parents, and all were between 18 and 40 years old (mean = 30.3).

The scale used to assess consumer risk-taking consisted of 30 seven-point items gauging one's propensity to engage in risky behaviors across five domains (recreational, financial, social, health-related, and ethical; 6 items per domain; Blais & Weber, 2006). Participants were asked to indicate, on a 1-7 scale, the likelihood of engaging in each of the listed activities if they were given the opportunity (1 = extremely unlikely, 7 = extremely likely). Since the current paper does not make a priori predictions regarding domain-specific components of risk-taking, we report herein only results relating to the composite measure of general risk-taking that encompasses all 30 items from the five domains ($\alpha = 0.92$; the 30 scores were averaged to generate one score of general risk-taking). However, it may be worthwhile to conduct all our analyses at the domain-specific level at a future time.

Results

We began our analyses by verifying that the five babies featured in the 15 baby stimuli photos were indeed perceived as cute by participants. One-sample t-tests revealed that participants perceived each of the five babies as being significantly cuter than an average baby (all five means above 5.5 on a 1-9 scale, all t values > 2.5, all 5 p values < .01). To test our hypothesis that baby exposure decreases risk-taking (H1) and to explore if parental status moderates this effect, an ANCOVA was performed (baby exposure and parental status as fixed factors). Since risk-taking is influenced by one's biological sex (Byrnes, Miller, & Schafer, 1999; Stenstrom et al., 2011) and by age (Wang et al., 1999), we added both these factors into the ANCOVA (sex as a fixed factor and age as a covariate). Results indicate that there was no significant main effect of baby exposure on

risk-taking ($F(1,166) = 0.42$, $p = .52$). However, a significant interaction was found between baby exposure and parental status on risk-taking ($F(1,166) = 11.15$, $p < .01$; see Figure 1). Thus, two planned mean comparisons were performed (two-tailed; the two reported *p*-values were multiplied by 2 to correct for multiple comparisons). First, non-parents in the baby present condition were significantly less risk-taking than non-parents in the baby absent condition ($M_{present} = 2.97$, $SD_{present} = 0.94$, $M_{absent} = 3.51$, $SD_{absent} = 1.04$, $t(1,75) = 2.41$, $p < .05$). Second, parents in the baby present condition exhibited significantly *greater* risk-taking proclivities than parents in the baby absent condition ($M_{present} = 3.40$, $SD_{present} = 1.08$ $M_{absent} = 2.82$, $SD_{absent} = 0.86$, $t(1,96) = 2.93$, $p < .01$). Thus, non-parents (but not parents) responded to baby exposure as we expected in H1. Specifically, baby exposure led to lesser risk-taking in non-parents and to greater risk-taking in parents. While the ANCOVA indicated that age was not a significant covariate, ($F(1,166) = 1.81$, $p = .18$), it did yield a significant main effect for sex such that men were significantly more risk-taking than women ($M_{men} = 3.52$, $SD_{men} = 1.10$, $M_{women} = 2.90$, $SD_{men} = 0.86$, $F(1,166) = 15.51$, $p < .01$). However, there was no significant three-way interaction between sex, baby exposure, and parental status ($F(1,166) = 0.25$, $p = .62$). Thus, the baby exposure effects among parents and non-parents did not manifest themselves differentially across males and females.

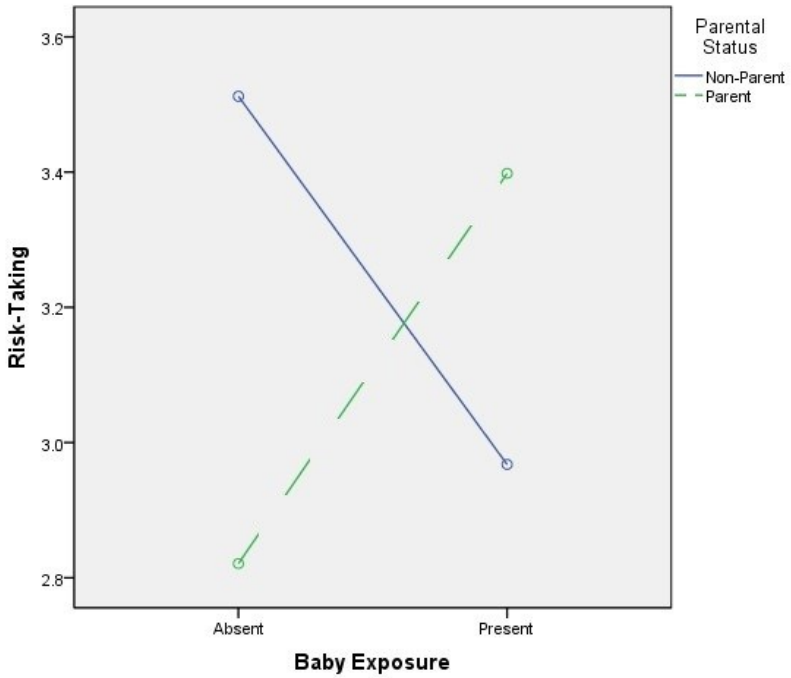

Figure 1. The Effect of Baby Photo Exposure on Risk-Taking Propensity, and the Moderating Role of Parental Status.

Discussion

The results from our sub-sample of non-parents support our hypothesis that exposure to baby photos leads to lesser risk-taking (H1). This finding is consistent with that of Fischer & Hills (2012), in which being paired with an infant in a cooperative risk-taking task led to lesser financial risk-taking in a sample of female undergraduate students, presumably consisting mainly of non-parents. Our finding adds to this research by showing that merely being exposed to baby stimuli can influence individual-level risk-taking. Essentially, non-parents seem to respond to being exposed to baby stimuli much like they would respond to becoming a new parent, with a reduction in risk-taking (Wang et al., 2009) and presumably testosterone (Gettler et al., 2011; Kuzawa et al., 2010).

However, future research is necessary to test if testosterone does indeed mediate the effect of baby exposure on risk-taking.

For parents, recall that we proposed two ways in which they might react to baby exposure differently than non-parents in terms of risk-taking. On the one hand, baby exposure may lead to even lesser risk-taking in parents than in non-parents if one's experiences as a parent promote enhanced responsiveness to baby cues. On the other hand, parents exposed to babies may engage in greater risk-taking if they perceive unfamiliar babies as a potential parental investment challenge and if such a threat increases testosterone levels. The results from our sub-sample of parents support the latter option, such that baby exposure elicited greater risk-taking among parents. Indeed, parents might feel threatened or challenged by the presence of unfamiliar babies because any care-taking of non-kin babies by parents would reallocate parental investment, a limited resource, away from their own offspring. Hence, parents may respond to photos of unfamiliar babies as a testosterone-increasing parental investment challenge, thereby triggering an increase in risk-taking. Of course, whether or not exposure to baby photos increases testosterone in parents should be tested empirically in future research.

The fact that we did not find a significant three-way interaction between sex, baby exposure, and parental status indicates that the effects of baby exposure on risk-taking among parents and non-parents manifest themselves similarly across both sexes. Recall that Fischer and Hills (2012) found that women but not men took less cooperative risks when grouped with an infant. They argue that this sex difference can be explained by parental investment theory (Trivers, 1972). Specifically, since women tend to invest more in offspring than men, women have more to lose from taking risks in the presence

of their infant. Although women may indeed have more to lose from taking risks while in the presence of babies, we expect that men would also suffer considerable loss of parental investment if their risky behavior leads to the harming of their offspring. Given the evidence suggesting that parenthood leads to decreases in testosterone (Gettler, McDade, Feranil, & Kuzawa, 2011; Kuzawa et al., 2010) and risk-taking (Wang et al., 2009) in both sexes, that men and women seem to be equally sensitive to the cuteness of baby faces (Parsons, Young, Stein, & Kringelbach, 2011), and that a reduction in risky behavior in parenthood is likely to increase the survivability of offspring for both mothers and fathers, it is not surprising that our baby exposure effects manifested themselves similarly across both sexes.

In study 2, we examine baby exposure effects using a different modality of communication, namely auditory stimuli. We devised an online survey to test our predictions that exposure to baby cries leads to greater risk-taking (H2) and that baby laughs lead to lesser risk-taking (H3). Further, we explore how parental status might moderate these baby exposure effects. We present study 2 in the ensuing section.

Study 2

Method

Study 2 was comprised of a 3 (baby sound exposure: absent, crying, laughing) x 2 (parental status: non-parents, parents) between-subjects design. The sample was recruited by Qualtrics Panels using a national (US) online panel and each respondent was given $1.25 payment for their work. Participants were presented with an online survey and were randomly assigned to one of three baby sound exposure conditions: baby laughing,

baby crying, or baby absent (neutral condition). In the baby laughing condition, participants were told that a diaper company required their help in choosing a baby's voice to be featured in a national radio advertisement campaign (see Appendix E). They were advised that the radio ad would feature a laughing baby to highlight how happy babies can be if they are wearing the advertised diapers. Participants were asked to listen to five 30-second sound clips, each featuring a different laughing baby, and to rate each baby in terms of the exhibited happiness using a scale of 1-9 (1 = not at all happy, 9 = extremely happy). The sound clips from all three conditions were selected from various online audio sources based on clarity. More precisely, we selected the first 5 baby sounds clips found from each category that were 1) at least 30 seconds long (they were subsequently shortened to be exactly 30 seconds long), 2) judged by the principal investigator to be clearly audible, and 3) contained only the emotional valence of interest. The task in the baby crying condition was identical to its baby laughing counterpart except that the radio ads were said to feature a crying baby, and that participants were asked to rate sound clips of crying babies in terms of their discomfort (see Appendix F). Participants were told that the goal of the ad was to highlight how uncomfortable a baby can feel if wearing inadequate diapers, and how switching to the advertised diaper brand can alleviate this discomfort (1 = not at all uncomfortable, 9 = extremely uncomfortable). The task in the baby absent condition was similar to that of the other two conditions, except that participants were told that a coffee company required their help in choosing an instrumental song that would be featured in a national radio advertisement campaign, and accordingly they were asked to rate sound clips of instrumental music in terms of likeability (1 = not at all likeable, 9 = extremely likeable; see Appendix G). As part of an

ostensibly unrelated second study, participants were subsequently presented with the same 30-item risk-taking scale (Blais & Weber, 2006; see Appendix B) used in Study 1 to fill out, followed by demographic questions (including sex and parental status), and additional measures outside the scope of the current paper. As in study 1, we excluded all respondents who did not completed the survey within 6 to 30 minutes as a means of ensuring quality control (i.e., to exclude those who finished too quickly to have read all the questions, and those who took so long that the effects of our priming manipulation were likely to have waned). After Qualtrics Panels excluded 35 respondents who took less than six or more than thirty minutes, 334 respondents remained. Additionally, we removed respondents who did not complete the manipulation task correctly. More precisely, we excluded 119 respondents who did not listen to each of the five 30-second sound clips (we monitored the amount of time each respondent spent on each separate sound clip page), which resulted in a final sample size of 215. Participants were 18-40 years old (mean = 29.5), 52% female, and 55% parents.

Results

An ANCOVA was performed to test if 1) baby cries lead to greater risk-taking (H2); 2) baby laughter leads to lesser risk-taking (H3); and 3) parental status moderates these effects. Accordingly, we entered baby sound exposure (absent, laughing, crying) and parental status into the model. As in study 1, we also entered sex and age into the ANCOVA. Although the results indicate that there is no significant main effect of baby exposure on risk-taking ($M_{\text{laugh}} = 3.06$, $SD_{\text{laugh}} = 0.70$, $M_{\text{cry}} = 3.12$, $SD_{\text{cry}} = .95$, $M_{\text{absent}} = 3.29$, $SD_{\text{absent}} = 1.03$, $F(2,202) = 0.50$, $p = .61$), they reveal a significant interaction

between baby exposure and parental status on risk-taking ($F(2,202) = 4.72$, $p = .01$; see Figure 2). Therefore, we performed four pair-wise comparisons (two-tailed; to correct for multiple comparisons, the four reported p-values were multiplied by 4). First, contrary to H2, baby cries led to lesser risk-taking among parents. More precisely, parents in the crying condition were significantly less risk-taking than parents in the baby absent condition ($M_{cry} = 2.74$, $SD_{cry} = 0.70$, $M_{absent} = 3.43$, $SD_{absent} = 1.14$, $t(1,78) = 3.33$, $p < .01$). Second, among non-parents, we found no significant difference in risk-taking between the crying condition and the baby absent condition ($M_{cry} = 3.48$, $SD_{cry} = 1.01$, $M_{absent} = 3.05$, $SD_{absent} = 0.79$, $t(1,64) = -1.94$, $p = .26$). Third, in support of H3, baby laughs led to lesser risk-taking among parents. Parents in the laughing condition were significantly less risk-taking than parents in the baby absent condition ($M_{laugh} = 2.91$, $SD_{laugh} = 0.70$, $M_{absent} = 3.43$, $SD_{absent} = 1.14$, $t(1,85) = 2.62$, $p < .05$). Fourth, there was no significant difference in risk-taking between the laughing condition and the baby absent condition among non-parents ($M_{laugh} = 3.24$, $SD_{laugh} = 0.69$, $M_{absent} = 3.05$, $SD_{absent} = 0.79$, $t(1,57) = 0.98$, $p = .99$).

Overall, the four pair-wise comparisons indicate that parents (but not non-parents) responded to baby sounds with lesser risk-taking, regardless of emotional valence. In line with previous research and with the results of study 1, the ANCOVA also showed that men reported taking significantly more risks than women ($M_{men} = 3.44$, $SD_{men} = 0.83$, $M_{women} = 2.91$, $SD_{men} = 0.91$, $F(1,202) = 19.73$, $p < .01$). Nonetheless, there was no sex*baby exposure*parental status interaction ($F(2,202) = 0.62$, $p = .94$), indicating that the effect of baby exposure on risk-taking among parents manifests itself equally across the sexes. The ANCOVA also revealed that age was a significant covariate ($F(1,202) =$

5.08, p = .03). A correlation analysis between age and risk-taking showed that older individuals engaged in lesser risk-taking than younger ones (r = -.141, p = .04), which is consistent with previous research (Wang et al, 2009).

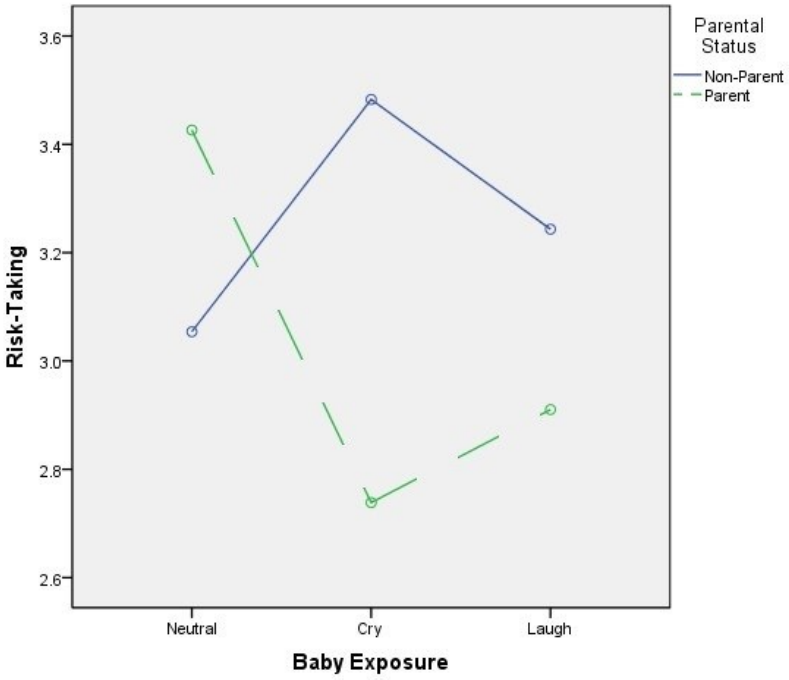

Figure 2. The Effect of Baby Sound Exposure (Laughing and Crying) on Risk-Taking Propensity, and the Moderating Role of Parental Status.

Discussion

Results of study 2 indicate that baby laughs led to lesser risk-taking among parents. While it remains unclear why this finding was not replicated in non-parents, overall these results lend partial support to H3. Specifically, these results suggest that merely being exposed to sounds of baby laughs can lead to a decrease in risk-taking, akin to the effects of parenthood (Wang et al., 2009). Given that parenthood leads to

decreases in testosterone (Gettler et al., 2011; Kuzawa et al., 2010) and that risk-taking is associated with testosterone (Apicella et al., 2008; van Honk et al., 2004), the effects of baby laughs on risk-taking among parents are likely to be associated with a decrease in testosterone. Furthermore, considering that baby laughter serves as a means of soliciting parental care-taking (Riem et al., 2012), the effects of baby laughs on risk-taking among parents might be associated with increases in parental care-taking motives.

Based on the Steroid/Peptide Theory of Social Bonds which stipulates that baby cries in the absence of nurturance leads to increases in testosterone (van Anders et al., 2011, 2012), we expected that baby cries in study 2 (which were not associated with nurturance) would lead to greater risk-taking via an increase in testosterone. Surprisingly, baby cries yielded a decrease in risk-taking among parents, and had no significant effect among non-parents. In other words, regardless of emotional valence, baby sounds led to lesser risk-taking among parents, but not among non-parents. Given that both baby cries and laughter ultimately serve as a means of soliciting parental care-giving (Riem et al., 2012; Zeifman, 2001), it is possible that both cries and laughs elicit feelings of parental care in parents, thereby leading to a decrease in risk-taking and testosterone. That said, future research is warranted to test if the effects of baby sounds on risk-taking are actually mediated by testosterone. Why were there no significant results relating to baby sounds (cries or laughter) among non-parents? Given the evidence suggesting that non-parents are less sympathetic to infant cries than parents (Fleming et al., 2002), these null effects may be because non-parents respond to baby sounds with less empathy than non-parents.

Consistent with our findings from study 1, the interaction between baby exposure and parental status was not significantly influenced by sex (i.e., there was no three-way interaction between sex, baby exposure, and parental status). Hence, the effects of baby exposure on risk-taking seem to manifest themselves similarly across men and women in both studies. Contrary to Fischer and Hills' (2012) findings relating to cooperative risk-taking that were limited to women, our findings across studies 1 and 2 lend support to the notion that men can be as sensitive to baby cues as women. That said, some research has found that men and women are differentially interested in (Maestripieri & Pelka, 2002), attentive towards (Cárdenas, Harris, & Becker, 2013; Charles, Alexander, & Saenz, 2013; Maestripieri & Pelka, 2002), and sensitive to baby stimuli (Lehmann, Huis in't Veld, & Vingerhoets, 2013). Thus, future research could investigate if there are subtle differences between men and women with regards to how mere exposure to baby sights and sounds might influence risk-taking in parents and non-parents.

In the next section, we discuss the overall theoretical and practical implications of our research.

General Discussion

Our theoretical framework is based on the Challenge Hypothesis, which posits that males will respond to parenthood with a decrease in testosterone (Archer, 2006; Wingfield, et al., 1990), a hormone associated with risk-taking (Appicella et al., 2008; Stanton, Liening, & Schultheiss, 2011; Stenstrom et al., 2011). We drew from the Challenge Hypothesis to posit that merely exposing individuals to photos of cute babies and sounds of baby laughter would elicit a decrease in risk-taking, presumably by

decreasing testosterone levels. We expected similar results across the sexes given the mounting evidence suggesting that Challenge Hypothesis applies similarly to women (Archer, 2006; Bateup et al., 2002; Edwards et al., 2006; Oliveira et al., 2009; Kuzawa et al., 2010). Furthermore, we drew from an extension of the Challenge Hypothesis called the Steroid/Peptide Theory of Social Bonds, which stipulates that baby cries in the absence of nurturance triggers an increase in testosterone (van Anders et al., 2011, 2012), to hypothesize that baby cries would lead to greater risk-taking. We conducted two studies to test these hypotheses and to explore how parental status might play a role in how baby exposure influences risk-taking. Results across two studies indicate that baby exposure can significantly impact risk-taking in men and women, and that this effect is moderated by parental status. Specifically, exposure to baby photos leads to lesser risk-taking among non-parents (study 1), while exposure to baby laughs leads to lesser risk-taking among parents (study 2). Surprisingly, parents responded to baby photos with an increase in risk-taking (study 1) and to baby cries with a decrease in risk-taking (study 2), and baby sounds did not have a significant effect on risk-taking among non-parents regardless of emotional valence (study 2). Therefore, baby exposure elicited lesser risk-taking as predicted, but only for baby photos among non-parents and for baby laughter and cries among parents.

Why did parents respond to baby sounds with lesser risk-taking (study 2), while responding to baby photos with greater risk-taking (study 1)? It is possible that parents view unfamiliar babies as a threat to their offspring's wellbeing since taking care of unfamiliar babies would reallocate parental investment away from their own children. Given that testosterone increases in response to threats (Archer, 2006), it is feasible that

exposure to photos of unfamiliar babies elicits an increase in testosterone, thereby leading to greater risk-taking. An extreme example of promoting the survivability of one's offspring at the cost of non-kin babies can be observed in the animal kingdom. Male lions who have recently gained reproductive access to a new pride of females (typically by killing or driving off the resident adult male(s)) commonly kill cubs that are not genetically theirs in an effort to trigger estrus in the females and promote the survivability of their own future offspring (Packer, 2000). Thus, photos of unfamiliar babies may elicit an avoidance response in parents, leading to greater risk-taking via an increase in testosterone. In contrast, it is possible that hearing baby cries and laughter may conjure up parents' memories of their own children. While baby faces are clearly identifiable as non-kin by parents, the source of baby sounds are more ambiguous and may therefore trigger memories of when their own children were babies. In line with this reasoning, new parents are often incapable of recognizing the cries of their own babies (Formby, 1967). For instance, Green and Gustafson (1983) found that 55% of fathers and 20% of mothers were incapable of recognizing their own infants' cries. Hence, baby sounds might elicit both memories of and care-taking motives toward one's offspring, thereby leading to lesser risk-taking via a decrease in testosterone. Since this explanation remains highly speculative, future research is warranted to explore if parents respond differently to baby stimuli of their own children versus stimuli of unfamiliar babies. We might expect parents to respond to photos of their own infants with lesser risk-taking, while responding to those of unfamiliar babies with greater risk-taking.

A possible explanation for our two null effects among non-parents in study 2 relates to the possible limitations of priming effects in general. Priming research has

recently come under scrutiny due to potential robustness issues (Doyen, Klein, Pichon, & Cleeremans, et al., 2012), with Daniel Kahneman calling for the creation of a replication ring within the field in order to avoid a "train wreck looming" (Yong, 2012). Others have cast doubt on the validity of certain published priming results, arguing that it is puzzling that one observation set in opposition to thousands of other observations throughout one's lifetime can lead to significant effects. Environmental inputs that generate behavioral plasticity are sampled across multiple time points, thereby rendering such "one-shot" priming manipulations tenuous from an evolutionary perspective (Kurzban, 2014). Likewise, parenthood entails multiple infant exposures involving a multitude of simultaneous communication modalities over a considerable period of time. In contrast, the infant primes utilized in our study 2 consisted of listening to only 150 seconds of baby sounds. Therefore, our two null effects in study 2 may be due in part to the auditory exposure of our baby prime being too limited to induce significant effects on risk-taking.

It should be noted that while we used both positively and negatively valenced auditory baby stimuli in study 2, all of the visual baby stimuli used in study 1 were positively valenced. Future research could investigate how negative visual stimuli (e.g., photos of crying babies) might influence risk-taking. As crying in the absence of nurturance typically leads to increases in testosterone (Fleming et al., 2002; Storey et al., 2000; van Anders et al., 2012), photos of crying babies may trigger a similar increase in testosterone, thereby leading to greater risk-taking. Alternatively, given our study 2 results wherein baby cries elicited a decrease in risk-taking among parents, we might expect photos of crying babies to lead to lesser risk-taking in parents. Another potential future research avenue would be to investigate how baby exposure effects on risk-taking

might be influenced by in-group congruency (e.g., same-race congruency). Of note, Hodsoll, Quinn, and Hodsoll (2010) found that racially congruent (but not racially incongruent) baby faces attracted greater attention than adult faces from South Asian and Caucasian adults. Indeed, coalitional thinking is a powerful innate inclination that leads individuals to feel more favorable and empathetic towards members of their own in-group than outsiders (Saad, 2007a, 2011). Thus, while we used racially diverse visual baby stimuli in the current research, future research could examine if in-group or racial congruency moderates the effects of baby exposure on risk-taking.

In terms of practical implications, our research helps marketing and public policy managers better understand how to curb or promote consumer risk-taking. Marketers often use babies in advertisement campaigns. While folk wisdom may suggest that the use of cute babies in advertisements is typically beneficial, our results suggest otherwise. Specifically, the effectiveness of baby-related advertisement campaigns for risk-related products and services depends on the parental status of their target market and on the communication modality of the baby stimuli utilized (sights vs. sounds). For instance, our results suggest that radio advertisements promoting safe behavior (e.g., drunk driving prevention) would likely increase their effectiveness by including baby sounds in advertisements targeting parents and by utilizing baby visuals when targeting non-parents in television or print ads. Similarly, marketers selling products and services that involve risk aversion (e.g., minivans, insurance policies, product warranties) should incorporate baby sounds into ads targeting parents and utilize baby visuals in advertisements targeting non-parents. Conversely, companies promoting products and services involving a considerable degree of risk (e.g., extreme sports, motorcycles, casinos, financial

trading) should include visuals of babies in their advertisements targeting parents in order to promote risk-seeking proclivities. Another practical implication relates to political campaigns. Politicians are often shown holding a baby while on the campaign trail, in television advertisements, and in campaign flyers. If voting for an incumbent is generally perceived by voters as a safer choice in an election, an incumbent should target non-parents with campaign ads and flyers containing images of him or her holding a cute baby. In contrast, the candidate challenging the incumbent can promote a riskier electoral choice by targeting parents with flyers and ads containing visuals of him or her holding a baby placed in parenting magazines (e.g., Parents, FamilyFun, Babytalk).

This research also has consumer welfare implications, as it can inform individuals of ways to avoid engaging in detrimental risk-taking behaviors. Our results suggest that parents can decrease their risk-taking proclivities by listening to baby cries or laughter, and that non-parents can curb their risk-taking by viewing photos of cute babies. Hence, non-parents who wish to reduce deleterious risk-taking (e.g., gambling, drunk driving) would likely benefit from adding baby photos to their environment (e.g., in their wallet, on their desk, or car dashboard). Similarly, since high testosterone levels have been shown to promote risk-taking among financial traders and may contribute to financial bubbles by amplifying the upward movements of markets (Coates & Herbert, 2008), it might be beneficial for financial traders to use baby stimuli to lower their testosterone levels and risk-taking (e.g., traders who are not parents can place a baby photo at their work desk). Likewise, non-parents who tend to engage in too much online gambling might benefit from placing baby photos by their computers.

Our conceptual model proposes that the effects of baby exposure on risk-taking are associated with concurrent variations in testosterone levels. However, future research should directly measure testosterone levels (e.g., via saliva sampling) to test if baby exposure effects on risk-taking are indeed associated with variations in testosterone. Additionally, there are other hormones or peptides that are associated with exposure to baby sounds such as prolactin (Delahunty, McKay, Noseworthy, & Storey, 2007; Fleming et al., 2002) and oxytocin (Riem et al., 2012; Strathearn, Fonagy, Amico, Montague, 2009). Furthermore, estradiol and cortisol have been associated to parental status (Berg & Wynne-Edwards, 2001), whereas vasopressin has been linked to parental aggression (Bosch, 2011; van Anders et al., 2011). Accordingly, future research should examine if the effects of baby exposure on risk-taking are indeed primarily associated with testosterone and how other hormones or peptides including oxytocin, prolactin, estradiol, cortisol, and vasopressin might play a role.

It is important to note that, while our conceptual model focuses on testosterone, it is feasible that the effects of baby exposure on risk-taking also involve other drivers such as emotions and/or cognitive processes. For instance, baby exposure may eliciting feelings of nurturance, which in turn could lead to lesser risk-taking. From a cognitive perspective, it is possible that baby exposure triggers thoughts of responsibility, which in turn could lead to lesser risk-taking. That said, any alternate affective and/or cognitive explanation would not oppose or contradict our physiological and evolutionary theorizing. Given the hormonal (Van Wingen, Ossewaarde, Bäckström, Hermans, & Fernandez, 2011) and evolutionary underpinnings of emotion and cognition (Cosmides & Tooby, 2000), providing additional affective and cognitive explanations would be

complementary to our hormonal and evolutionary conceptualization, thereby offering a more complete understanding of the phenomena in question.

Another potential future research avenue consists of exploring the impact of exposure to babies from other species or to inanimate objects possessing infantile features. Since other animals (Archer & Monton, 2011; Borgi & Cirulli, 2013; Fullard & Reiling, 1976), toys (Hinde & Bearden, 1985), and cars (Windhager et al., 2008; Miesler et al., 2011) can be perceived as having infantile features, future research could investigate if viewing cute animals or infant-like products might influence risk-taking.

There are several factors that might affect the extent to which baby stimuli have an effect on an individual. For instance, interest in babies is influenced by age (Maestripieri & Pelka, 2002), relationship status (Charles, Alexander, & Saenz, 2013) digit ratio (a proxy of prenatal testosterone; Charles, Alexander, & Saenz, 2013), and personality traits such as empathy and need to belong (Lehmann, Huis in‘t Veld, & Vingerhoets, 2013). Accordingly, future research could investigate how baby effects on risk-taking might be moderated by the aforementioned factors.

While our examination of social influence (i.e., baby effects) from a hormonal perspective is novel to the marketing literature, the current paper adds to a growing body of work investigating hormonal effects on consumer decision-making (Durante, Griskevicius, Cantú, & Simpson, 2014; Durante, Griskevicius, Hill, Perilloux, & Li, 2011; Saad & Stenstrom, 2012; Stenstrom & Saad, 2011; Stenstrom et al., 2011; Saad & Vongas, 2009). More broadly, the current work builds on the expanding literature at the nexus of evolutionary psychology and consumer behavior (Griskevicius & Kenrick, 2013; Griskevicius, Tybur, & Van den Bergh, 2010; Griskevicius et al., 2009; Janssens et

al., 2011; Miller, 2009; Saad & Gill, 2000; Saad, 2006b, 2007a, 2008, 2010, 2011, 2013; Saad & Stenstrom, 2012).

CONCLUDING REMARKS

Across three papers, we have explored various ways in which testosterone influences consumer risk-taking. Our review of the literature on testosterone and risk-taking in paper one suggests that testosterone has organizational and activational effects on risk-taking. While the findings in this research stream are partly mixed, the overall evidence suggests circulating testosterone levels, digit ratio, and facial masculinity are associated with financial risk-taking. Furthermore, since financial risk-taking and pathological gambling share phenomenological and neurobiological commonalities, we argue that circulating testosterone, digit ratio, and facial masculinity may be predictors of pathological gambling susceptibility.

In paper two, we investigated if testosterone has organizational effects on risk-taking across a variety of domains. We examined the relationship between digit ratio (2D:4D and *rel*2) and risk-taking in five domains, namely recreational, financial, social, ethical, and health-related. The results of our study demonstrate that digit ratio is associated with recreational, financial, and social risk-taking (but not health-related or ethical risk-taking) in Caucasian males. Our findings suggest that high-testosterone men may be engaging in greater social, financial, and recreational risk-taking as a way of signalling traits such as confidence, athleticism, ambition, and social dominance.

In our final paper, we focused on the activational effects of testosterone. Across two studies, we examined the impact of a baby exposure, a purported driver of testosterone levels, on consumer risk-taking. The findings indicate that exposure to baby photos leads to lesser risk-taking in non-parents, while leading to greater risk-taking among parents. Our results among non-parents suggest that they respond to baby photo

exposure in a manner akin to parenthood, namely with a decrease in testosterone and risk-taking. Our findings among parents suggest that they might respond to photos of unfamiliar babies as a parental investment challenge, thereby eliciting an increase in testosterone and risk-taking. Further, we demonstrate that exposure to baby laughs and cries leads to lesser risk-taking among parents. These results suggest that baby sounds, regardless of emotional valence, elicit parental care-taking motives in parents, thereby leading to a decrease in testosterone and risk-taking. Lastly, the effects of baby exposure on risk-taking manifested themselves equivalently in men and women in both studies, which supports the notion that the two sexes can be equally sensitive to baby stimuli.

Each of the three papers presented in this thesis add to an emerging body of work connecting hormones to consumer behavior (Durante et al., 2011, 2014; Saad & Stenstrom, 2012; Saad & Vongas, 2009), and to the field of evolutionary consumption (Griskevicius & Kenrick, 2013; Saad, 2007a, 2011, 2013). Taken together, these three papers suggest that future research would gain from examining risk-taking from an inter-disciplinary perspective by considering hormonal, evolutionary, and social factors.

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APPENDICES

Appendix A: Paper 2, Risk-Taking Scale (Weber et al., 2002)

Note: The items were presented in a randomized order.

For each of the following statements, please indicate the <u>likelihood of engaging in each activity</u>. Provide a rating from 1 to 5, using the following scale:

1	2	3	4	5
Extremely unlikely		Not sure		Extremely likely

<u>Financial:</u>

- Investing in a business that has a good chance of failing.
- Lending a friend an amount of money equivalent to one month's income.
- Spending money impulsively without thinking about the consequences.
- Taking a day's income to play the slot-machines at a casino.
- Taking a job where you get paid exclusively on a commission basis.
- Betting a day's income at the horse races.
- Co-signing a new car loan for a friend.
- Investing 10% of your annual income in a blue chip stock.
- Investing 10% of your annual income in a very speculative stock.
- Investing 10% of your annual income in a government bonds (treasury bills).

<u>Recreational:</u>

- Trying bungee jumping.
- Exploring an unknown city or section of town.
- Going camping in the wild.
- Going down a ski run that is too hard or closed.
- Going on a safari in Kenya.
- Going on a two-week vacation in a foreign country without booking accommodations ahead.
- Going whitewater rafting at high water in the spring.
- Traveling on a commercial airplane.
- Periodically engaging in a dangerous sport (e.g., mountain climbing or sky diving).
- Chasing a tornado by car to take photos that you can sell to the press.

Social:

- Admitting that your tastes are different from those of your friends.
- Arguing with a friend who has a very different opinion on an issue.
- Asking your boss for a raise.
- Dating someone that you are working with.
- Deciding to share an apartment with someone you don't know very well.
- Disagreeing with your father on a major issue.
- Moving to a new city.
- Openly disagreeing with your boss in front of your coworkers.
- Speaking your mind about an unpopular issue at a social occasion.
- Wearing unconventional clothes.

Ethical:

- Buying an illegal drug for your own use.
- Cheating a fair amount on your income tax.
- Cheating on an exam.
- Driving home after you had three drinks in the last two hours.
- Forging somebody's signature.
- Illegally copying a piece of software.
- Plagiarizing a term paper.
- Shoplifting a small item (e.g., a lipstick or pen).
- Stealing an additional TV cable connection.
- Using office supplies for your personal business.

Health:

- Eating "expired" food products that still "look okay."
- Frequent binge drinking.
- Ignoring some persistent physical pain by not going to the doctor.
- Taking a medical drug that has a high likelihood of negative side effects.
- Engaging in unprotected sex.
- Never using sunscreen when you sunbathe.
- Never wearing a seatbelt.
- Not having a smoke alarm in or outside of your bedroom.
- Smoking a pack of cigarettes per day.
- Regularly riding your bicycle without a helmet.

Appendix B: Paper 3, Studies 1 & 2, Risk-Taking Scale (Blais & Weber, 2006)

Note: The items were presented in a randomized order.

For each of the following statements, please indicate on a scale of 1-7 the likelihood of you engaging in each activity if you had the opportunity to do so now.

1	2	3	4	5	6	7
Extremely unlikely			Not sure			Extremely likely

Financial:

- Betting a day's income at the horse races
- Investing 5% of your annual income in a very speculative stock
- Betting a day's income at a high-stake poker game
- Betting a day's income on the outcome of a sporting event
- Investing 10% of your annual income in a new business venture
- Investing 10% of your annual income in a moderate growth mutual fund

Recreational:

- Going down a ski run that is beyond your ability
- Bungee jumping off a tall bridge
- Piloting a small plane
- Taking a skydiving class
- Going whitewater rafting at high water in the spring
- Going camping in the wilderness

Social:

- Disagreeing with an authority figure on a major issue
- Choosing a career that you truly enjoy over a more secure one
- Speaking your mind about an unpopular issue in a meeting at work
- Moving to a city far away from your extended family
- Starting a new career in your mid-thirties
- Admitting that your tastes are different from those of a friend

Ethical:

- Taking some questionable deductions on your income tax return
- Having an affair with a married man/woman
- Passing off somebody else's work as your own
- Revealing a friend's secret to someone else
- Leaving your young children alone at home while running an errand
- Not returning a wallet you found that contains $200

Health:

- Driving a car without wearing a seat belt
- Drinking heavily at a social function
- Engaging in unprotected sex
- Riding a motorcycle without a helmet
- Sunbathing without sunscreen
- Walking home alone at night in an unsafe area of town

Appendix C: Paper 3, Study 1, Baby Present Scenario

Note: the actual stimuli that were used in these studies were omitted from this manuscript for privacy concerns. If you would like to see the stimuli, please contact the authors.

Study 1: Yum-Yums Baby Food Contest

Yum-Yums, a Canadian baby food company, created a contest to find the next "Yum-Yums baby." They asked consumers to send in photos of their baby. The winning baby will be featured in the next Yum-Yums ad campaign.

Yum-Yums would like to know your opinion on which baby you think would make the best "Yum-Yums baby."

We will show you a series of photos of 5 babies (3 photos for each baby). For each baby, please take a good look at their 3 photos and then rate the baby in terms of cuteness using the 1-9 scale below.

Looking carefully at all 3 photos above, overall how cute is baby 1?

not at all cute				neutral				extremely cute
1	2	3	4	5	6	7	8	9

In your opinion, what are this baby's two cutest features (in 20 words or less)?

Appendix D: Paper 3, Study 1, Baby Absent (Neutral) Scenario

Study 1: Tourism Canada Contest

Tourism Canada created a consumer contest to find photos of the most beautiful scenes in Canada. They asked consumers to send in photos that best represent the beauty of Canadian cities and/or landscapes. The winning set of photos will be featured in the next Tourism Canada ad campaign.

Tourism Canada would like to know your opinion on which photos you think would best represent the beauty of Canada.

We will show you a series of photos of Canadian cities and/or landscapes (3 pictures for each contest participant).

For each participant, please take a good look at their 3 photos and then rate the set of pictures in terms of beauty using the 1-9 scale below.

Looking carefully at all 3 photos above, overall how beautiful are participant 1's photos?

not at all beautiful				neutral				extremely beautiful
1	2	3	4	5	6	7	8	9

In your opinion, what are the two most beautiful aspects of this participant's photos (in 20 words or less)?

Appendix E: Paper 3, Study 2, Baby Laughing Scenario

Study 1: Baby Voice Choice for Radio Advertisement

A leading diaper company needs your help to choose a baby's voice to be featured in a national radio advertisement campaign. The ad, scheduled to air this summer, will promote the firm's new line of diapers. This new line of diapers has been shown to outperform all competing brands in leakage and comfort tests.

The radio ad will feature a baby who is laughing. The goal of the ad is to show how happy babies can be if they are wearing this new line of diapers.

The diaper company would like to know your opinion on which of several baby voices sounds the happiest.

We will ask you to listen to five 30-second sound clips, each featuring a baby who is laughing. For each sound clip, please listen to the entire 30-second clip carefully, and then rate the voice in terms of happiness using the 1-9 scale below.

Please make sure that the volume of your computer is high enough to hear the sounds clearly.

Step 1: Listen carefully to the entire 30-second sound clip of baby 1. Wait for the sound clip to end at the 30-second mark before moving on.

Step 2: After you've finished listening to the entire 30-second clip of baby 1, please rate the baby's voice in terms of happiness using the 1-9 scale below.

not at all happy			moderately happy			extremely happy		
1	2	3	4	5	6	7	8	9

Appendix F: Paper 3, Study 2, Baby Crying Scenario

Study 1: Baby Voice Choice for Radio Advertisement

A leading diaper company needs your help to choose a baby's voice to be featured in a national radio advertisement campaign. The ad, scheduled to air this summer, will promote the firm's new line of diapers. This new line of diapers has been shown to outperform all competing brands in leakage and comfort tests.

The radio ad will feature a baby who is crying because his diaper is wet and uncomfortable. The goal of the ad is to show how uncomfortable babies can be if they are wearing inadequate diapers, and then show how switching to the advertised diapers can help babies feel more comfortable.

The diaper company would like to know your opinion on which of several baby voices sounds the most uncomfortable.

We will ask you to listen to five 30-second sound clips, each featuring a baby who is crying. For each sound clip, please listen to the entire 30-second clip carefully, and then rate the voice in terms of discomfort using the 1-9 scale below.

Step 1: Listen carefully to the entire 30-second sound clip of baby 1. Wait for the sound clip to end at the 30-second mark before moving on.

Step 2: After you've finished listening to the entire 30-second clip of baby 1, please rate the baby's voice in terms of discomfort using the 1-9 scale below:

not at uncomfortable			moderately uncomfortable			extremely uncomfortable		
1	2	3	4	5	6	7	8	9

Appendix G: Paper 3, Study 2, Baby Absent (Neutral) Scenario

Study 1: Music Choice for Radio Advertisement

A leading coffee company needs your help to choose music to be featured in a national radio advertisement campaign. The ad, scheduled to air this summer, will promote the firm's new line of specialty coffees. This new line of specialty coffees has been received very positively in taste tests.

The coffee company would like to know your opinion on which of several songs you like the most.

We will ask you to listen to 5 sound clips featuring a song. For each sound clip, please listen to the song carefully and then rate it in terms of likeability using the 1-9 scale below.

Step 1: Listen carefully to the entire 30-second sound clip of song 1. Wait for the sound clip to end at the 30-second mark before moving on.

Step 2: After you've finished listening to the entire 30-second clip of song 1, please rate the song in terms of likeability using the 1-9 scale below:

not at likeable				moderately likeable				extremely likeable
1	2	3	4	5	6	7	8	9