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Research Article

Testosterone at your fingertips: Digit ratios (2D:4D and *rel*2) as predictors of courtship-related consumption intended to acquire and retain mates

Marcelo Vinhal Nepomuceno [a,*], Gad Saad [b], Eric Stenstrom [c], Zack Mendenhall [d], Fabio Iglesias [e]

[a] *Department of Marketing, HEC Montréal, 3000, chemin de la Côte-Sainte-Catherine, Montréal, Québec H3T 2A7, Canada*
[b] *Department of Marketing, John Molson School of Business, Concordia University, 1455 de Maisonneuve, West Montreal, QC H3G 1M8, Canada*
[c] *Department of Marketing, Farmer School of Business, Miami University, Oxford, OH 45056, United States*
[d] *Desautels Faculty of Management, McGill University, Bronfman Building, Department of Marketing, 1001 Sherbrooke Street, West Montreal, QC, H3A 1G5, Canada*
[e] *Laboratório de Psicologia Social Universidade de Brasília Campus Universitário Darcy Ribeiro, Ala Sul do Instituto Central de Ciências, Sala A1-120 Asa Norte 70900-100, Brasilia, DF, Brazil*

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Abstract

While hormones have been shown to impact a wide range of behaviors, little is known regarding their influence on consumer behavior. The current research examines the association between digit ratios and courtship-related consumption. Digit ratios (2D:4D and *rel*2) are indicators of prenatal testosterone exposure and are assessed by measuring finger length. In Study 1, masculinized digit ratios (low digit ratios, high prenatal testosterone) in men were associated with greater courtship-related consumption to acquire mates, and this association was stronger for men with high mating confidence. In women, feminized digit ratios (high digit ratios, low prenatal testosterone) were associated with greater courtship-related consumption to acquire mates. In Study 2, men with masculinized digit ratios engaged in greater courtship-related consumption by offering romantic gifts as a means of retaining mates. In women, feminized digit ratios were associated with greater romantic gift giving. Our findings suggest that high prenatal testosterone in men leads to greater courtship-related consumption, whereas low prenatal testosterone leads to greater courtship-related consumption in women.

Keywords: Prenatal testosterone; Digit ratio (2D:4D, *rel*2); Gift giving; Sex differences; Mating confidence

Introduction

Despite strong theoretical reasons for a wider incorporation of the biological sciences into consumer research (Griskevicius & Kenrick, 2013; Miller, 2009; Saad, 2007, 2008, 2011, 2013), consumer scholars have long neglected this potentially fruitful avenue. The use of biological variables in the marketing literature has largely focused on psychophysiological responses to marketing stimuli (see Wang & Minor, 2008 for a review). For instance, recent advances in neuroimaging techniques have led to the identification of brain activation patterns associated with advertising response (Morris et al., 2009), product choice tasks (Hedgcock & Rao, 2009; Knutson, Rick, Wimmer, Prelec, & Loewenstein, 2007), and brand judgments (McClure et al., 2004; Yoon, Gutchess, Feinberg, & Polk, 2006). Other physiological variables that have been measured in conjunction with marketing stimuli include electrodermal activity (Aaker, Stayman, & Hagerty, 1986), vascular activity (Frost & Stauffer, 1987), facial muscle activity (Bolls, Lang, & Potter, 2001), salivation (Gal, 2012) and pupillary dilation (Krugman, 1964).

* Corresponding author. Fax: +1 514 340 5631.
E-mail addresses: marcelo.nepomuceno@hec.ca (M.V. Nepomuceno), gadsaad@jmsb.concordia.ca (G. Saad), stenstep@miamioh.edu (E. Stenstrom), zachary.mendenhall@mail.mcgill.ca (Z. Mendenhall), fabiglesias@gmail.com (F. Iglesias).

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In spite of the compelling evidence associating hormones with behavior (Archer, 2006; Fessler, 2003; Gangestad, Thornhill, & Garver-Apgar, 2005; Mazur & Booth, 1998), few studies have explored the role of hormones in understanding consumer behavior (Saad, 2007, 2011). Recent efforts have tried to fill this gap in the literature. For instance, oxytocin administration has been shown to increase the effectiveness of public service announcements (Lin, Grewal, Morin, Johnson, & Zak, 2013). In addition, the menstrual cycle and associated hormonal shifts have been shown to influence consumer behavior. Specifically, women chose sexier clothing, engage in greater beautification behavior (Durante, Griskevicius, Hill, Perilloux, & Li, 2011; Durante, Li, & Haselton, 2008; Haselton, Mortezaie, Pillsworth, Bleske-Rechek, & Frederick, 2007; Röder et al., 2009; Saad & Stenstrom, 2012), and prefer products that improve social standing during the fertile phase of the menstrual cycle (approximately days 8 to 15; Durante, Griskevicius, Cantú, & Simpson, 2014). In addition, food-related desires, consumption, and purchasing behavior increase at the luteal phase (approximately days 21–28; Saad & Stenstrom, 2012). Furthermore, Saad and Vongas (2009) demonstrated that men's circulating testosterone levels increased after driving a luxurious sports car. In the current research, we examine how an indicator of prenatal exposure to testosterone, namely digit ratio, is associated with consumer behavior.

Prenatal testosterone exposure has an important influence on brain organization and future dispositions and behaviors (Archer, 2006; Auyeung et al., 2009; Udry, 2000). Incidentally, prenatal testosterone exposure inhibits the growth of the second digit (index finger) relative to the remaining three fingers. Consequently, digit ratio (typically measured as the second-to-fourth digit ratio, or 2D:4D), offers a rough estimate of the extent of this exposure (Lutchmaya, Baron-Cohen, Raggatt, Knickmeyer, & Manning, 2004; Manning, Bundred, Newton, & Flanagan, 2003; Manning, Scutt, Wilson, & Lewis-Jones, 1998). Low (i.e., masculinized) digit ratios reflect high prenatal exposure to testosterone, whereas high (i.e., feminized) digit ratios reflect low prenatal exposure to testosterone (Manning et al., 1998). Only one study to date has explored the association between digit ratio and consumer behavior. Aspara and Van den Bergh (2014) found that, among men (but not women), masculinized digit ratio was associated with preferences for masculine products (e.g., Regular Coke, gray shirt), whereas feminized digit ratio was associated with preferences for feminine products (e.g., Diet Coke, light red shirt). Despite this finding, the influence of prenatal testosterone on consumer behavior remains largely unexplored.

The goal of the current paper is to explore how prenatal testosterone influences courtship-related consumption. We define courtship-related consumption as consumer behaviors used to woo potential or current mates. We study two types of courtship-related consumption, one to acquire mates (i.e., to start a new amorous relationship) and the other to retain mates (i.e., to maintain a current amorous relationship). Someone engaging in courtship-related consumption to acquire mates might go to the gym or use cosmetics to improve one's physical appearance in order to perform better in the mating market (Buss, 1988). Someone engaging in courtship-related consumption to retain mates, whether it is at the very beginning of a relationship or several years into one, might offer romantic gifts because gifts are frequently used as a courtship tactic (Saad & Gill, 2003). Prior Hönekopp et al., 2006; Manning & Fink, 2008; Manning et al., 2000). Given that prenatal testosterone promotes reproductive drive in men, and that a high reproductive drive is likely to lead to greater consumption behaviors meant to woo potential and/or current mates, we propose that prenatal testosterone will lead to greater courtship-related consumption in men. In Study 1, we show that masculinized digit ratios are associated with greater courtship-related consumption to acquire mates in men. In Study 2, we show that masculinized digit ratios are associated with greater courtship-related consumption to retain mates in men. Hence, our results suggest that prenatal testosterone leads to greater courtship-related consumption as a means of both acquiring new mates (Study 1) and retaining current ones (Study 2) in men.

In women, we build on prior work showing that feminized digit ratios in women have been associated with greater reproductive drive and success (Manning & Fink, 2008). Specifically, we demonstrate that feminized digit ratios are associated with greater courtship-related consumption to acquire mates (Study 1) and to retain them (Study 2). Given that feminized digit ratio is indicative not only of low prenatal testosterone exposure but also of high prenatal estrogen exposure (Manning et al., 1998), our results suggest that women with high prenatal estrogen-to-testosterone ratio engage in greater courtship-related consumption.

The current research goes beyond looking at the correlation between digit ratios and courtship-related consumption by investigating the moderating role of an individual's mating confidence. We define mating confidence as the perceived ease with which one gains sexual access to others (Landolt, Lalumiere, & Quinsey, 1995). In men, we demonstrate that mating confidence strengthens the association between digit ratios and courtship-related consumption to acquire mates (Study 1), but not to retain mates (Study 2). In women, mating confidence does not strengthen the association for acquiring or retaining mates.

Our paper is organized as follows. In the ensuing section, we review the relevant literature on testosterone, courtship-related consumption, and mating confidence. Subsequently, we present two studies. In Study 1, we explore how digit ratio is associated with courtship-related consumption to acquire mates. In Study 2, we examine the relationship between digit ratio and courtship-related consumption to retain mates. In both studies, we investigate the potential moderating role of mating confidence. We conclude with a discussion of future research and implications.

Conceptual framework

The masculinizing effect of prenatal testosterone

Testosterone is a masculinizing agent that has long-term organizational effects on the body and brain, as well as real-time activational effects on behavior (Archer, 2006). Activational effects are not bound to specific developmental

stages and can be triggered in a wide array of social settings. Such effects include positive associations between circulating testosterone and dominant, aggressive, and anti-social behaviors (Archer, 2006; Dabbs & Morris, 1990; Mazur & Booth, 1998), and negative associations between circulating testosterone with mate bonding (Burnham et al., 2003), parental investment (Gray, Kahlenberg, Barrett, Lipson, & Ellison, 2002), and generosity (Zak et al., 2009). Organizational effects reflect the long-term influence of testosterone exposure during a developmentally important life stages (i.e., in utero or at puberty). For instance, prenatal testosterone promotes genital virilisation (Rey & Picard, 1998), a masculine gender identity, and masculine toy preferences (Hines, 2006). In addition, pubertal testosterone promotes height and masculinized facial structure (Olweus, Mattsson, Schalling, & Low, 1980). While there are two studies indicating an association between circulating testosterone and digit ratios (Manning, Stewart, Bundred, & Trivers, 2004; Manning et al., 1998), the large majority of studies have found no correlation between these two measures (Apicella et al., 2008; Muller et al., 2011; see Hönekopp et al., 2007 for a review). Overall, the evidence suggests that digit ratio and current circulating testosterone are distinct, with digit ratios being indicative of organizational effects of prenatal testosterone and with current circulating testosterone being an indicator of activational effects of testosterone. In the current paper, we focus on the long-term organizational effects of testosterone by examining the association between digit ratios and courtship-related consumption.

Given its theoretical importance and ease of measurement, digit ratio has received immense attention in psychology, biology, and anthropology. In fact, Voracek and Loibl (2009) identified over 300 articles published between 1998 and 2009 that examined the link between digit ratio and various dispositions and behaviors. For example, masculine digit ratios in men have been associated with typically more masculine traits such as aggression (Bailey & Hurd, 2005; McIntyre et al., 2007; Ronay & Galinsky, 2011), dominance (Manning & Fink, 2008; Neave, Laing, Fink, & Manning, 2003), and performance in various types of athletic ability such as tennis (Hsu et al., 2015), soccer (Manning & Taylor, 2001), grip strength (Fink, Thanzami, Seydel, & Manning, 2006), sprinting (Manning & Hill, 2009), and endurance running (Manning, Morris, & Caswell, 2007). Digit ratios are sexually dimorphic, such that men tend to have more masculinized ratios than women (Manning et al., 1998). While most research on testosterone has focused primarily on men, the masculinizing effects of testosterone are not limited to them (Archer, 2006). Female athletes have more masculinized digit ratios compared to their non-athlete counterparts (Pokrywka, Rachon, Suchecka-Rachon, & Bitel, 2005), and women with more masculinized digit ratios exhibit greater sporting ability (Hull, Schranz, Manning, & Tomkinson, 2015; Paul, Kato, Hunkin, Vivekanandan, & Spector, 2006). Similarly, women with more masculinized ratios exhibit more aggressive behaviors when provoked (Benderlioglu & Nelson, 2004; Ronay & Galinsky, 2011). Further, female homosexuals with more feminized digit ratios identify themselves as more "femme," and those with more masculinized ratios considered themselves more "butch" (Brown, Finn, Cooke, & Breedlove, 2002). Therefore, the literature suggests that prenatal testosterone exposure leads to more masculinized traits and behaviors in both men and women.

Thus far, research on the organizational effects of testosterone has rarely addressed consumption directly. Some studies found that masculine digit ratios are associated with greater recreational and financial risk-taking (Coates & Page, 2009; Stenstrom, Saad, Nepomuceno, & Mendenhall, 2011), greater financial trading performance (Coates, Gurnell, & Rustichini, 2009), and greater future discounting (Millet & Dewitte, 2008). The only study that employed traditional consumer behavior variables found that, among men (but not women), masculinized digit ratio was associated with greater preferences for masculine products, whereas feminized digit ratio was associated with greater preferences for feminine products (Aspara & Van den Bergh, 2014). Overall, the literature indicates that prenatal testosterone exposure has a masculinizing effect across a wide range of human phenomena, but the effects of prenatal testosterone remain largely understudied within marketing. In the present research, we sought to answer two questions investigating how testosterone might influence consumer behavior: (1) Does the exposure to prenatal testosterone influence courtship-related consumption in men and women? (2) Does mating confidence moderate the relationship between testosterone and courtship-related consumption in men and women?

Courtship-related consumption in men

When acquiring mates, men are more likely to display and brag about resources to impress women (Buss, 1988). For example, men are more likely to engage in conspicuous consumption by choosing visibly expensive products when trying to impress women (Griskevicius et al., 2007; Saad, 2007, 2011; Sundie et al., 2011). Also to impress women, men may use cologne or go to the gym to develop a more athletic built (Buss, 1988). When retaining mates, whether it is a few dates into a relationship or 30 years into a marriage, men may offer romantic gifts in order to signal romantic intent and commitment (Saad, 2007, 2011; Saad & Gill, 2003). We expect that these courtship behaviors will be associated with testosterone. According to previous research, men with masculinized digit ratios are more likely to report having greater sex drive (Manning & Fink, 2008), number of children (Manning & Fink, 2008; Manning, Henzi, Venkatramana, Martin, & Singh, 2003; Manning et al., 2000), and number of sexual partners (Hönekopp et al., 2006). Given that prenatal testosterone promotes sex drive in men, and that sex drive motivates individuals to search for and court potential mates (Fisher, 1998; Fisher, Aron, Mashek, Li, & Brown, 2002), we expect that having a high sex drive will engender greater consumption behaviors meant to attract and/or retain mates. Therefore, we propose that men exposed to greater prenatal testosterone will engage in greater courtship-related consumption.

H1. In men, masculinized digit ratios will be associated with greater courtship-related consumption to acquire and retain mates.

Courtship-related consumption in women

As compared to men, women use different tactics to court mates. They are more likely to wear makeup, jewelry, and stylish clothes to impress men (Buss, 1988). In contrast to the testosterone literature on men suggesting that high prenatal testosterone exposure may be associated with greater courtship-related consumption, the literature on women points to two conflicting theories on how prenatal testosterone might influence courtship-related consumption. On one hand, given that prenatal testosterone exposure has been associated with masculine traits and behaviors in both men (Fink et al., 2006; Manning & Taylor, 2001) and women (Benderlioglu & Nelson, 2004; Csathó et al., 2003; Hull et al., 2015; Paul et al., 2006; Pokrywka et al., 2005), and that men tend to compete more vigorously than women when courting (Buss & Schmitt, 1993; Trivers, 1972), one might expect masculinized digit ratios to be associated with greater courtship-related consumption in women as well. In other words, since competing vigorously when courting is a more masculine behavior, and since prenatal testosterone has been associated with masculine behaviors and traits in women, one could argue that masculinized digit ratios would be predictive of greater courtship-related consumption in women.

On the other hand, since feminized digit ratios in women have been associated with greater sex drive and reproductive success (Manning & Fink, 2008; Manning, Henzi et al., 2003), one might expect that feminized digit ratios are predictive of greater courtship-related consumption. Of note, digit ratios are indicative not only of prenatal testosterone exposure, but also of prenatal estrogen exposure (Lutchmaya et al., 2004; Manning, 2011; Manning, Kilduff, Cook, Crewther, & Fink, 2014; Manning et al., 1998). That is, an individual with a feminized digit ratio was exposed to high prenatal estrogen levels relative to prenatal testosterone levels, whereas an individual with a masculinized digit ratio was exposed to low prenatal estrogen levels relative to prenatal testosterone levels. In other words, a feminized digit ratio is indicative of a high prenatal estrogen-to-testosterone ratio. In contrast to the masculinizing effects of prenatal testosterone, prenatal estrogen is involved in the feminization of the fetal brain and future behavior (Bakker & Baum, 2008; Manning, 2002; McCarthy, 2008). Given that the ratio of prenatal estrogen to testosterone promotes sex drive in women, and that sex drive motivates the courting of potential mates (Fisher, 1998; Fisher et al., 2002), we might expect feminized digit ratios to be associated with greater courtship-related consumption in women. We will test these two competing theories by examining how women's digit ratios are associated with courtship-related consumption in the current research. Thus, given the conflicting evidence, we take an exploratory approach by not favoring either of these two competing theories.

The moderating role of mating confidence

Recall that there are two types of courtship-related consumption, one to acquire mates (e.g., taking a new acquaintance out to dinner) and one to retain them (e.g., romantic gift giving). Within our theoretical framework, mating confidence is important when acquiring mates because we expect the effects of prenatal testosterone on courtship-related consumption to acquire mates to be strengthened by it. Men with high mating confidence believe that members of the opposite sex are strongly attracted to them and that they can have as many sexual partners as they desire (Landolt et al., 1995). Because men with high mating confidence should have the self-assurance required to approach potential new mates (e.g., a man asking a beautiful woman he recently met out to dinner), the effect of prenatal testosterone on courtship-related consumption to acquire mates should be strongest for men with high mating confidence. Some of the male-based courtship rituals are riskier because they involve a risk of rejection. Therefore, we expect that the association between digit ratios and courtship-related consumption will be moderated by mating confidence in men. However, we do not expect this moderation to be operational in women. While women vary in terms of mating confidence, most courtship-related consumption behaviors intended to acquire mates in women may not require mating confidence. For example, most courtship behaviors in women such as wearing jewelry are passive and coy in nature, thereby being less risky and not requiring much mating confidence. Whether women are high or low in mating confidence, they should engage in the same types of courtship-related consumption (women might wear jewelry irrespective of their mating confidence). In contrast, many courtship behaviors in men are active and brazen, such as buying dinners at nice restaurants and showing off possessions, and consequently are likely to require mating confidence. In line with this reasoning, Landolt et al. (1995) found that mating confidence was associated with mating tactics in men but not in women. Thus, we test:

H2. In men, the association between digit ratios and courtship-related consumption to acquire mates will be strongest among those with high mating confidence.

While we expect that mating confidence will play a moderating role for courtship-related consumption to acquire mates in men, we do not expect this moderation to occur when retaining mates in either sex. In the current research, we focus on courtship-related consumption to retain mates by examining gifts given within the context of an existing romantic relationship. Mating confidence in men should facilitate the acquisition of mates because one needs self-assurance to approach and court potential new mates in men. However, mating confidence should not influence romantic gift giving because doing so mainly signals commitment toward one's current mate, which does not necessitate any self-assurance. Given that romantic gift giving does not require mating confidence, we do not expect mating confidence to moderate the association between digit ratios and romantic gift giving in either sex.

Digit ratio and ethnicity

Previous research has shown that digit ratios vary significantly between ethnicities (Fink et al., 2006; Manning, Churchill, & Peters, 2007; Manning & Fink, 2008). For example, research comparing the digit ratios across three ethnically homogeneous samples (England, India, and South Africa) found that the English had the most masculinized digit ratios, followed by Indians, with the most feminized digit ratios found among South Africans (Manning, Henzi et al., 2003). In another multi-ethnic study, Manning et al. (2004) measured digit ratios of four ethnicities in three locations (Berbers from Morocco, Uygurs and Han from the North-West province of China, and Afro-Caribbeans from Jamaica). They found that the Oriental Han had more masculinized digit ratios than Caucasian Berbers and Uygurs, whereas Caucasian Berbers and Uygurs had more masculinized ratios than Afro-Caribbean Jamaicans. Given that digit ratios vary greatly between ethnicities, the standard when samples are ethnically heterogeneous is to control for ethnicity by grouping participants in ethnically homogeneous groups and running separate analyses on the ethnically homogeneous subsamples that are large enough to permit it (Manning & Fink, 2008; Peters, Manning, & Reimers, 2007; Stenstrom et al., 2011). In some studies, there are multiple subsamples that are sufficiently large to allow for the relevant analyses to be conducted (Manning et al., 2000; Peters et al., 2007), while in other studies there is only one subsample large enough to permit the running of the analyses in question (Manning & Fink, 2008; Stenstrom et al., 2011). Therefore, in our two studies, we control for ethnicity by dividing our samples into ethnically homogeneous groups and running separate analyses on the ethnically homogeneous subsample(s) that are large enough to allow such analyses. We present Study 1 in the following section.

Study 1: Digit ratios, courtship-related consumption to acquire mates, and mating confidence

In the current study, we investigate the association between digit ratios and courtship-related consumption to attract mates in men and women. In addition, we test whether mating confidence moderates this association.

Method

The vast majority of digit ratio studies have used 2D:4D as an indicator of prenatal testosterone exposure. However, Loehlin, Medland, and Martin (2009) tested the efficacy of several new measurements of digit ratio. They showed that the length of all four digits, relative to the second digit (abbreviated as "*rel*2") outperformed 2D:4D when discriminating between males and females. Further evidence has indicated that all four fingers are influenced by prenatal testosterone. For instance, Burton, Henninger, and Hafetz (2005) reported that 2D:5D (ratio of the index to pinky fingers) performed as well as 2D:4D in discriminating between men and women. Similarly, McIntyre, Cohn, and Ellison (2006) found that 3D:4D (middle finger to ring finger) was better than 2D:4D at discriminating males from females in a sample of Chinese children. Moreover, Stenstrom et al. (2011) found that *rel*2 tended to yield stronger effects regarding men's risk-taking proclivities than 2D:4D. Thus, it may prove beneficial to measure *rel*2 as opposed to 2D:4D given that the former encompasses all four fingers. Additionally, Loehlin et al. (2009) reported that the absolute effect size of *rel*2 is more than twice that of *rel*3, *rel*4 or *rel*5. However, Voracek (2009) found that *rel*2 did not perform significantly differently from 2D:4D, in terms of discriminating between men and women. In the current study, we wish to shed some light on these equivocal findings by including measurements of both 2D:4D and *rel*2.

Our sample consisted of 500 students from highly ethnically heterogeneous backgrounds recruited in Brazil. Participants answered the questionnaires on a university campus, both in and out of classrooms. The survey also included other scales that fall outside the scope of the current study. Trained experimenters used digital calipers to measure the lengths of the right-hand fingers of each participant, as right-hand digit ratios tend to yield stronger sex differences than left-hand ratios (Loehlin et al., 2009; Voracek, Tran, & Dressler, 2010). To calculate 2D:4D, we divided the length of the second digit by the length of fourth digit. To calculate *rel*2, we divided the length of the second digit by the sum of the lengths of the second, third, fourth, and fifth digits. To measure mating confidence, we used a 6-item, 1-factor scale by Landolt et al. (1995) called the Self-Perceived Mating Success Scale. Examples of items from this scale include "I can have as many sexual partners as I choose" and "Members of the opposite sex that I like, tend to like me back" (7-point Likert-type scale, with 1 = "completely disagree" to 7 = "completely agree"). The Cronbach alpha for this scale was .87.

To measure courtship-related consumption to acquire mates, we developed items based on previous research relating to tactics of mate attraction (Buss, 1988). This research shows that women and men differ in the tactics used to acquire mates. Thus, we prepared one version of the scale for each sex. For the male version, we selected courtship-related consumption behaviors that were more frequently used by men than by women. Conversely, for the female version we selected courtship-related consumption behaviors that were more frequently used by women than by men. Courtship-related consumption behaviors that were common in both sexes were included in both versions of the scale. This process resulted in 14 courtship-related consumption items for men and 12 courtship-related consumption items for women. Examples of items in the female version are "I wore makeup that accentuated my looks" and "I wore jewelry." Examples of items in the male sample are "I went to the gym to become attractive" and "Whenever I bought something expensive, I showed it off to women." Participants were instructed to indicate how often they engage(d) in each of the behaviors to become more attractive to the opposite sex when they are (were) single (1 = never, 7 = always). Finally, participants concluded the study by answering several demographic questions to identify their ethnicity, age, and whether they had fractured any of their fingers.

To assess the intra-experimenter and inter-experimenter reliabilities of the digit ratio measurements, we visited a

separate class consisting of 21 students. Each participant was measured six times (twice by each of the three experimenters). The inter-experimenter and intra-experimenter intraclass correlation coefficients (ICC) are presented in Table 1, and are within the norms of previous digit ratio studies (Voracek, Manning, & Dressler, 2007).

Twenty-five participants who had had broken fingers were removed from the final analysis. We also removed 77 participants who reported being either homosexual or bi-sexual, as our focus is on courtship-related consumption that heterosexuals engage in to acquire mates of the opposite sex. This resulted in a sample of 398 participants. Given that men tend to have more masculinized digit ratios than women (Manning et al., 1998), we grouped participants by sex and ran separate analyses for men and women. In addition, recall that digit ratios vary significantly between ethnicities (Fink et al., 2006; Manning & Fink, 2008; Manning, Churchill et al., 2007). Therefore, as in previous digit ratio studies (Manning & Fink, 2008; Stenstrom et al., 2011), we controlled for ethnicity by dividing participants into ethnically homogeneous groups and running our analyses on the group(s) that are large enough to permit it. Brazil is very ethnically heterogeneous, and Parra et al. (2003) demonstrated that Brazilians' definition of race is a poor predictor of their genetic ancestry. The researchers showed that individuals classified as blacks had a large proportion of non-African ancestry (48%). Likewise, they showed that Caucasian Brazilians had a large amount of African (28%) and Amerindian (33%) ancestry. Given the unreliability of self-reported ethnicity in Brazilian samples, we identified one's ethnicity based on the country of origin of their ancestors rather than self-reported ethnicity. We asked participants to identify whether their ancestors were from Portugal, sub-Saharan Africa, Spain, Japan, Korea, China, England, Germany, Lebanon, Syria, France, Italy, Ukraine or Russia. If necessary, they could indicate other countries and they could choose more than one option when applicable. Using this method, we identified 217 participants whose descendants were European (i.e., Caucasian). We chose this subsample because it was our largest homogeneous group and its sample size was large enough to run analyses. The second largest homogeneous group consisted of descendants from sub-Saharan Africa and was not large enough to warrant conducting analyses (n = 17). Finally, for the presented analyses we removed four outliers in terms of digit ratio, using Cook's distance as the exclusion criterion (Fox, 1991). This resulted in a final sample of 213 Caucasians. We conducted our analyses using strictly the data of Caucasian males (n = 101) and Caucasian females (n = 112). The average age was 21.3 years (SD = 5.33) and 52.6% of the participants were women.

Table 1
Intra-experimenter and inter-experimenter intraclass correlation coefficients — Study 1.

		*rel*2	2D:4D
Intra-experimenter ICC	Experimenter 1	.967	.975
	Experimenter 2	.840	.830
Inter-experimenter ICC	Trial a	.885	.835
	Trial b	.867	.886

Results

To assess the reliability of the scales presented in Tables 2 and 3, we conducted sequential exploratory factor analyses. We removed five and two items in the male and female versions of the scale respectively because they had at least one of the following problems: the item did not have a factor loading of at least .45 on at least one factor; the item had a factor loading of above .30 on more than one factor; the alpha increased with its exclusion. After removing the problematic items, a one-factor solution was obtained for each of the two sexes. The factor loadings, Cronbach's alpha, average score and standard deviation resulting from this exercise are presented in Tables 2 and 3. We began by comparing the digit ratios between the sexes to establish whether the expected sex differences are observed in our sample. *Rel*2 was significantly different between the sexes, with men yielding, as expected, lower (more masculinized) ratios (M_{men} = .250, SD_{men} = .0051, M_{women} = .252, SD_{women} = .0056; $F(1, 209) = 4.12$; p = .04). 2D:4D yielded lower ratios in men as well, which were only marginally significant different (M_{men} = .965, SD_{men} = .0306, M_{women} = .972, SD_{women} = .0322; $F(1, 209) = 2.60$, p = .10). We calculated the effect size of the sex difference for *rel*2 and 2D:4D and obtained Cohen's d values of .28 and .22 respectively, which correspond to small effect sizes in the expected direction. Fig. 1 illustrates high and low digit ratios. Next, we ran descriptive analyses on mating confidence for both sexes. In men, mating confidence was equal to 3.44 (SD = 1.15), whereas in women mating confidence was equal to 3.53 (SD = 1.22). Mating confidence was not significantly different between the sexes ($F(1, 209) = .285$, $p > .10$).

To test our hypotheses, we performed moderated regression analyses with 2D:4D or *rel*2 as the independent variable, mating confidence as the moderator, and courtship-related consumption to acquire mates as the dependent variable. We performed these

Table 2
Items retained after the exploratory factor analysis — courtship-related consumption to attract new mates (male sample).

	Factor loading
1 — I went to the gym to become attractive	.81
2 — I went regularly to the gym	.80
3 — Whenever possible, I wore clothes that show that I have been working out	.78
4 — I kept physically fit to create a healthy appearance	.70
5 — I wore stylish clothes	.65
6 — I went to parties to meet women	.60
7 — I used a special cologne before going out	.55
8 — Whenever I bought something expensive, I showed it off to women	.49
9 — I bought dinners for women at nice restaurants	.46
Mean score (standard deviation): 3.54 (1.13)	

Items excluded after factor analysis:
10 — I talked about how good I was in sports.
11 — I played sports.
12 — I kept myself clean and groomed.
13 — I flashed a lot of money in front of women.
14 — I mentioned that I expected to earn a lot of money.

Table 3
Items retained after the exploratory factor analysis — courtship-related consumption to attract new mates (female sample).

	Factor loading
1 — I wore makeup that accentuated my looks	.79
2 — I wore stylish clothes	.74
3 — I kept myself clean and groomed	.73
4 — I used a special perfume before going out	.73
5 — I wore a necklace	.68
6 — I used creams and oils frequently	.66
7 — I wore earrings	.61
8 — I wore jewelry	.60
9 — I kept physically fit to create a healthy appearance	.56
10 — I went to parties to meet men	.49
Mean score (standard deviation): 4.67 (1.28)	

Items excluded:
11 — I laid out in the sun to get a tan.
12 — I played sports.

analyses once for men and once for women. In both sexes, the interactions between digit ratios and mating confidence were obtained by standardizing the digit ratios and mating confidence, and then multiplying the transformed scores. If the interaction term is significant (Aiken & West, 1991), then mating confidence is a significant moderator. In support of H1, we found a negative correlation between 2D:4D and courtship-related consumption in men ($\beta = -.22, t = -2.31, p = .02$), indicating that masculinized digit ratios are associated with greater courtship-related consumption. As expected, there was a significant interaction between digit ratio and mating confidence on courtship-related consumption in men ($\beta = -.19$, $t = -1.972$, $p = .05$). The graphical representation of these results shows that 2D:4D and courtship-related consumption correlate more strongly when mating confidence is high than when mating confidence is low (see Fig. 2), thereby supporting H2. These results of the moderated regression analysis with 2D:4D are presented in Table 4. It is worth noting that 2D:4D was negatively correlated with mating confidence in men ($r(97) = -.24, p = .02$). In further support of H1, we found a negative correlation between *rel*2 and courtship-related consumption in men ($\beta = -.24$, $t = -2.577$, $p = .01$), indicating that masculinized *rel*2 is associated with greater courtship-related consumption. However, the interaction of *rel*2 with mating confidence did not correlate significantly with courtship-related consumption in men ($\beta = -.12$, $t = -1.284$, $p = .20$). It should be noted that there was a marginally significant negative correlation between *rel*2 and mating confidence in men ($r(97) = -.17$, $p = .09$). To be thorough, we reran our models without mating confidence and found that the correlations between digit ratios and courtship-related consumption remained significant ($r_{rel2}(94) = -.28$, $p < .01$; $r_{2D:4D}(94) = -.24$, $p = .02$).

In women, we obtained a positive correlation between 2D:4D and courtship-related consumption ($\beta = .21$, $t = 2.316$, $p = .02$), and a positive correlation between *rel*2 and courtship-related consumption ($\beta = .18$, $t = 2.037$, $p = .04$). Therefore, feminized digit ratios are associated with greater courtship-related consumption in women. As expected, mating confidence did not moderate the association between digit ratios and courtship-related consumption ($p > .10$ for 2D:4D and *rel*2). In addition, mating confidence was not correlated with digit ratios in women ($p > .10$ for 2D:4D and *rel*2). As in men, when we reran our models while omitting mating confidence in women, the correlations between digit ratios and courtship-related consumption remained significant ($r_{rel2}(109) = .19$, $p = .04$; $r_{2D:4D}(109) = .21$, $p = .03$).

Although we do not expect any significant digit ratio findings to emerge without controlling for ethnicity, to be thorough we repeated the analyses reported above on the homogeneous sub-samples, using the full samples of all ethnicities combined (multi-ethnic males, $n = 195$; multi-ethnic females, $n = 203$). As expected, no significant result relating to digit ratio was found when ethnicity was not controlled for. In addition, we repeated the analyses on the multi-ethnic samples while including ethnicity as a dummy variable (0 = Caucasian, 1 = non-Caucasian) as well as the relevant interaction terms (i.e., ethnicity*digit ratio and ethnicity*mating confidence). In men, there was a significant

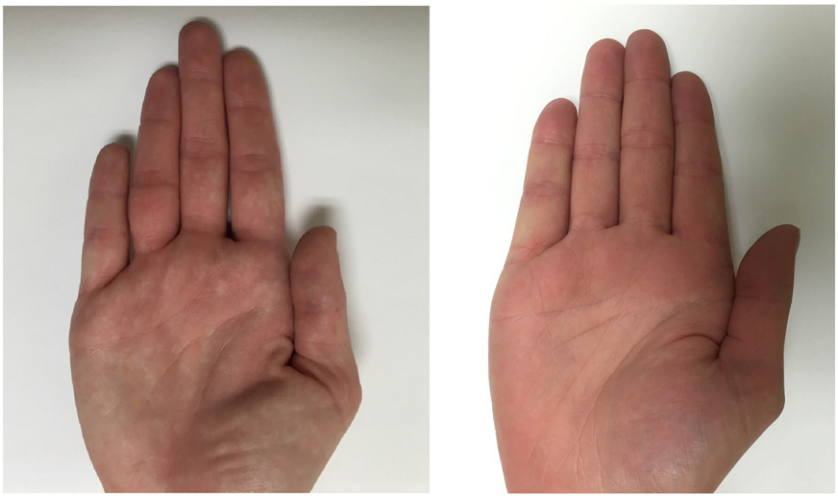

Fig. 1. The hand on the left has feminized digit ratios (2D:4D = 1.046; *rel*2 = 0.265), while the hand on the right has masculinized digit ratios (2D:4D = .0919; *rel*2 = 0.243).

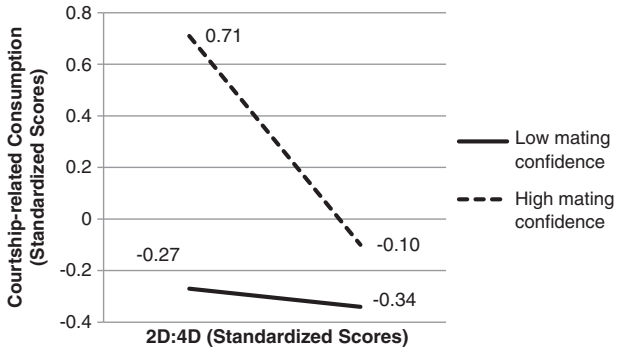

Fig. 2. Interaction of 2D:4D and mating confidence on courtship-related consumption in men.

interaction between *rel2* and ethnicity on courtship-related consumption ($\beta = .25$, $t = 3.569$, $p < .001$). Likewise, we found a significant interaction between 2D:4D and ethnicity on courtship-related consumption in men ($\beta = .19$, $t = 2.725$, $p < .01$). In women, while the interaction between *rel2* and ethnicity on courtship-related consumption was not significant ($\beta = -.10$, $t = -1.595$, $p = .11$), we identified a marginally significant interaction between 2D:4D and ethnicity on courtship-related consumption ($\beta = -.12$, $t = -1.85$, $p = .07$). Overall, these findings reinforce the need to control for ethnicity by restricting our analyses to the Caucasian homogeneous subsamples.

Discussion

We proposed that men with masculinized digit ratios would engage in greater courtship-related consumption meant to acquire mates (H1). Our results support this proposition, thereby suggesting that prenatal testosterone promotes courtship-related consumption in men. In Study 2, we further test this association by examining the relationship between digit ratios and courtship-related consumption meant to retain mates.

In addition, we posited that the association between digit ratios and courtship-related consumption to acquire mates would be strongest for men with high mating confidence (H2). As expected, men with masculinized digit ratios who possessed high mating confidence engaged in greater courtship-related consumption. This finding indicates that for men, mating confidence seems to moderate the influence of prenatal testosterone on courtship-related consumption meant to acquire mates. It is likely the case that this moderation was not observed in women because most courtship-related consumption behaviors intended to acquire mates tend to be less risky and more passive and coy in nature in women (beautifying) than in men (buying dinners for women they are courting), and therefore may not require much mating confidence.

Table 4
Regression for predicting courtship-related consumption to acquire mates.

	Males		Females	
Variables	Standardized beta	Sig.	Standardized beta	Sig.
2D:4D	−.22	.02	.21	.02
Mating confidence	.30	.002	.36	<.001
Interaction: mating confidence and 2D:4D	−.19	.05	−.06	.53
Adjusted R^2	.187		.162	

While gauging the two conflicting theories regarding the association between digit ratios and courtship-related consumption in women, we found that feminized digit ratios are associated with greater courtship-related consumption to acquire mates. Of note, digit ratios are indicative not only of prenatal testosterone exposure, but also of prenatal estrogen exposure (Lutchmaya et al., 2004; Manning, 2011). In other words, a feminized digit ratio is indicative of a high prenatal estrogen-to-testosterone ratio. Therefore, our documented link between feminized digit ratios and greater courtship-related consumption in women indicates that both greater prenatal estrogen and lesser prenatal testosterone might lead to greater courtship-related consumption in women. In line with this reasoning, Manning and Fink (2008) argue that their results showing that feminized digit ratios are associated with greater reproductive drive and success in women are due to a greater prenatal estrogen-to-testosterone ratio. Although the effects of prenatal estrogen and circulating estrogen may not necessarily be equivalent, high circulating estrogen levels have been associated with greater appearance-related consumption. For instance, circulating estrogen levels were positively correlated with provocative attire at a nightclub in women (Grammer, Renninger, & Fisher, 2004). Further, appearance-related consumption increases during the fertile phase of the menstrual cycle (Durante et al., 2008, 2011; Haselton et al., 2007; Saad & Stenstrom, 2012), when estrogen levels are at their highest (Scepkowski, Georgescu, & Pfaus, 2006). Given that circulating estrogen is a driver of courtship-related consumption in women, and in light of the fact that the ratio of prenatal estrogen to testosterone promotes sex drive, it is quite conceivable that our results associating feminized digit ratios with greater courtship-related consumption are driven by a high prenatal estrogen-to-testosterone ratio. In Study 2, we further test this association by investigating whether feminized digit ratios in women are associated with romantic gift giving, a form of courtship-related consumption intended to retain mates.

While in Study 1 we focused on the association between digit ratio and courtship-related consumption intended to acquire mates, Study 2 examines courtship-related consumption meant to retain existing mates.

Study 2: Digit ratios and courtship-related consumption to retain mates

The goal of Study 2 is to build on Study 1 by investigating the association between prenatal testosterone exposure and courtship-related consumption meant to retain current mates. Specifically, we examine the association between digit ratio and romantic gift giving. Gift giving fulfils several social functions. It can convey caring feelings to others and be used when celebrating special occasions (Belk, 2005; Goodwin,

Smith, & Spiggle, 1990). Likewise, offering gifts promotes trust and cooperation between individuals (Carmichael & MacLeod, 1997). We focus on one particular context of gift giving, namely that which occurs during a romantic relationship (Huang & Yu, 2000; Saad, 2007, 2011). Since romantic gift giving constitutes a multi-billion dollar market, an estimated 17.6 billion dollars is spent on Valentine's Day in the US alone (National Retail Federation, 2012), a greater understanding of the drivers of romantic gift giving has important practical and economic implications.

In Study 2, we further test H1 by examining if masculinized digit ratios are associated with greater courtship-related consumption to retain mates in men. Specifically, we test whether men with masculinized digit ratios are more likely to offer romantic gifts. Additionally, we evaluate the two conflicting theories regarding the association between digit ratios and courtship-related consumption to retain mates in women, namely that masculinized digit ratios are associated with greater or lesser courtship-related consumption. More precisely, we explore if digit ratios are associated with romantic gift giving in women.

Method

A sample of 499 Brazilian students participated in the study. The average age was 21.25 and 51.8% of participants were female. Congruent with the procedure used in Study 1, participants answered the surveys on a university campus, both in and out of classrooms. Trained experimenters measured the lengths of the right-hand fingers of each participant using digital calipers. We used a separate sample of 21 participants to measure the intra-experimenter and inter-experimenter reliabilities. The results of the intraclass correlation coefficients (ICC) are presented in Table 5 and all are within the norms of the digit ratio literature (Voracek et al., 2007).

Participants completed a survey that included a measure of romantic gift giving, some demographic questions, and the self-perceived mating success scale (Landolt et al., 1995) to measure mating confidence. The survey also included items that fall outside the scope of the current paper. For the romantic gift giving measure, participants were asked to "Imagine that they were in a committed romantic relationship and to indicate the likelihood of giving each of the following gifts to your boyfriend (girlfriend), using a scale from 1 to 7 (1 = "not likely at all" to 7 = "extremely likely")." The items used to measure romantic gift giving were, "flowers", "chocolates/candies," and "love letters." The Cronbach alpha for this measure was .60 in women and .65 in men. The Cronbach alpha for the six items that compose mating confidence was .86.

As in Study 1, we controlled for ethnicity by asking participants to indicate the country or region of their ancestors are from. This resulted in a sample of 279 participants whose ancestors were only from European countries, where Caucasians are the majority of the population. This sub-sample was selected for the analysis because it was large enough to allow analyses. The second largest homogeneous sub-sample was of Asian descent and was not large enough to justify conducting analyses on it (n = 9). We removed 153 participants from the analyses who reported having had broken fingers. We also removed four six outliers in terms of digit ratios using Cook's distance as the exclusion criterion (Fox, 1991). This resulted in a sample of 260 Caucasians.

Results

Consistent with prior digit ratio literature and with Study 1, men had lower (more masculinized) *rel*2 (M_{men} = .250, SD_{men} = .0058, M_{women} = .252, SD_{women} = .0066; $F(1, 258) = 3.80$, $p = .05$). However, there were no significant sex differences for 2D:4D (M_{men} = .966, SD_{men} = .0322, M_{women} = .971, SD_{men} = .0367; $F(1, 258) = 1.60$, $p = .20$). Preliminary analyses examining sex differences in romantic gift giving show that men are more likely to offer romantic gifts than women (M_{men} = 4.79, SD_{men} = 1.45, M_{women} = 4.20, SD_{women} = 1.28; $F(1, 256) = 11.96$, $p < .001$). Also, women scored significantly higher than men on mating confidence (M_{men} = 3.93, SD_{men} = 1.04, M_{women} = 4.51, SD_{women} = 1.30; $F(1, 251) = 15.03$, $p < .0001$).

Next, we ran moderated regression analyses for both sexes with 2D:4D or *rel*2 as the independent variable, mating confidence as the moderator, and romantic gift giving as the dependent variable. The results indicate that men's *rel*2 was negatively correlated with romantic gift giving ($\beta = -.24$, $t = -2.644$, $p = .01$; see Table 6 for all *rel*2 results). This supports H1, as masculine digit ratios were associated with greater courtship-related consumption to retain mates in men. Furthermore, we found a significant positive correlation between *rel*2 and romantic gift giving in women ($\beta = .18$, $t = 2.01$, $p = .05$). Therefore, feminine digit ratios were associated with greater courtship-related consumption to retain mates in women. Finally, as expected, we did not find a significant interaction between mating confidence and *rel*2 on romantic gift giving in either sex ($p > .30$). This suggests that mating confidence does not moderate the association between digit ratios and courtship-related consumption to retain mates in both sexes. It is worth noting that mating confidence did not correlate with *rel*2 or 2D:4D for men or women (all *p-values* > .10). As in Study 1, we reran our models without mating confidence. The correlations between digit ratios and romantic gift-giving remained largely unchanged in men ($r_{rel2}(122) = -.23$, $p = .01$; $r_{2D:4D}(122) = -.18$, $p = 05$) and in women ($r_{rel2}(130) = .17$, $p = .05$; $r_{2D:4D}(130) = .13$, $p = .13$).

Recall that we used two measures of digit ratios, *rel*2 and 2D:4D. Our moderating regressions using 2D:4D yielded results similar to when using *rel*2. The only exception occurred

Table 5
Intra-experimenter and inter-experimenter intraclass correlation coefficients — Study 2.

		*rel*2	2D:4D
Intra-experimenter ICC	Experimenter 1	.943	.949
	Experimenter 2	.871	.807
Inter-experimenter ICC	Trial a	.896	.799
	Trial b	.799	.769

for the correlation between 2D:4D and romantic gift giving in women, which was only marginally significant for 2D:4D ($\beta = .15$, $t = 1.701$, $p = .09$) albeit recall that it was significant for *rel*2 ($\beta = .18$, t = 2.01, $p = .05$). When comparing the performance of the two digit ratio measures, the results of the moderated regressions were stronger when *rel*2 was used. Specifically, the adjusted R^2 was larger with *rel*2 than with 2D:4D in both moderated regression analyses (.018 vs. .015 in women; .038 vs. .019 in men).

While we do not expect to find any significant digit ratio results when ethnicity is not controlled for, we repeated our analyses using the full samples with all ethnicities combined (multi-ethnic males, $n = 217$; multi-ethnic females, $n = 238$) in order to be thorough. As anticipated, no significant results relating to digit ratio emerged without controlling for ethnicity. As in Study 1, we also repeated the analyses using the multi-ethnic samples with ethnicity as a dummy variable (0 = Caucasian, 1 = non-Caucasian) and with the relevant interaction terms. We removed four outliers using Cook's distance as the exclusion criterion (Fox, 1991). In men, we found a significant interaction between *rel2* and ethnicity on romantic gift-giving ($\beta = .15$, t = 2.054, p = .04). Also in men, we found a marginally significant interaction between 2D:4D and ethnicity on romantic gift-giving ($\beta = .12$, t = 1.622, p = .10). In women, we found a significant interaction between *rel2* and ethnicity on romantic gift-giving ($\beta = .13$, t = 1.989, p = .05), and a marginally significant interaction between 2D:4D and ethnicity on romantic gift-giving ($\beta = .12$, t = 1.773, p = .08). As in Study 1, our findings using a multi-ethnic sample while entering a dummy variable for ethnicity reinforces the need to separate our sample into ethnically homogeneous groups and run our main analyses on the largest ethnically homogeneous subsample (i.e. Caucasians).

Discussion

In further support of H1, our Study 2 results indicate that masculinized digit ratios are associated with men's greater propensity to offer romantic gifts, which suggests that prenatal testosterone exposure in men promotes courtship-related consumption intended not only to acquire mates (Study 1), but also to retain them. In women, recall that we found that feminized digit ratios were associated with greater courtship-related consumption to acquire mates (Study 1). In Study 2, we found that digit ratios are associated with greater courtship-related consumption to retain mates (i.e., romantic gifts) in women. Considering that feminized digit ratios are indicative of not only low prenatal testosterone but also high prenatal estrogen (Manning & Fink, 2008; Manning et al., 1998; Manning et al., 2014), our finding associating feminized digit ratios to greater romantic gift giving provides further support to the premise that a high prenatal estrogen-to-testosterone ratio promotes courtship-related consumption in women. Overall, the findings from Study 2 regarding the association between digit ratio and courtship-related consumption replicate those from Study 1 in both men and women.

Table 6
Regression for predicting romantic gift giving.

	Males		Females	
Variables	Standardized beta	Sig.	Standardized beta	Sig.
*rel*2	−.24	.01	.18	.05
Mating confidence	.04	.64	−.02	.81
Interaction: mating confidence and *rel*2	−.07	.43	.09	.33
Adjusted R^2	.038		.018	

Whereas mating confidence strengthens the association between prenatal testosterone and courtship-related consumption to acquire mates in men but not women (Study 1), the results of Study 2 suggest that mating confidence does not strengthen the association between prenatal testosterone and courtship-related consumption to retain mates (via romantic gift giving) for either sex. Mating confidence might not be operative here because offering romantic gifts does not require self-assurance signal commitment toward one's current mate.

General Discussion

Our paper offers three main theoretical contributions. First, our results across two studies demonstrate that masculinized digit ratios in men are associated with greater courtship-related consumption to acquire mates (Study 1) and to retain current ones by offering romantic gifts (Study 2). These findings indicate that prenatal testosterone exposure in men not only lead to more masculinized behaviors (Bailey & Hurd, 2005; Manning & Hill, 2009; Neave et al., 2003), greater preferences for masculine products (Aspara & Van den Bergh, 2014), and greater sex drive and reproductive success in men (Hönekopp et al., 2006; Manning & Fink, 2008), but also greater investment of time and energy into mate-seeking and mate-keeping behaviors by engaging in greater courtship-related consumption.

Second, recall that we tested two competing theories regarding how prenatal testosterone might influence courtship-related consumption in women. We found that feminized digit ratios in women were associated with greater courtship-related consumption to acquire mates (Study 1) and retain them by offering romantic gifts (Study 2). These findings do not support the theory that, since prenatal testosterone leads to more masculinized behavior in women (Benderlioglu & Nelson, 2004; Csathó et al., 2003; Paul et al., 2006), it should lead to greater courtship-related consumption. Rather, our results support the theory that a high prenatal estrogen-to-testosterone ratio in women leads not only to greater sex drive (Manning & Fink, 2008), but also to greater courtship-related consumption. Interestingly, the fact that digit ratios are shaped by an estrogen-to-testosterone ratio (Manning et al., 2014) might partly explain multiple published accounts of null effects in digit ratio research in women. For example, masculine traits such as physical aggression, grip strength, and risk taking have been found to correlate with digit ratios in men (Bailey & Hurd, 2005; Fink et al., 2006; Stenstrom et al., 2011) but not in women (Bailey & Hurd, 2005; Lyons & Helle, 2013; Stenstrom et al., 2011; van Anders, 2007). These null findings may be partly explained by the fact that most prior digit ratio research has investigated dependent variables that relate to the

masculinizing effects of testosterone (e.g., physical aggression), rather than those that relate to the feminizing effects of estrogen (or of estrogen-to-testosterone ratio; e.g., courtship-related consumption). Given that our findings in women might be explained by estrogen-to-testosterone ratio, future digit ratio research should consider investigating dependent variables that are relevant to the feminizing effects of estrogen (e.g., nurturance, empathy).

The third main contribution of this paper is that mating confidence appears to moderate the effects of prenatal testosterone exposure on courtship-related consumption. Specifically, the effects of prenatal testosterone on courtship-related consumption to acquire mates in men seem to be strongest when mating confidence is high. This moderation was not operative in women, possibly because courtship-related consumption in women may not require much confidence (e.g., women with feminized digit ratios might wear jewelry regardless of whether they are low or high in mating confidence). While the courtship-related consumption to acquire mates examined in Study 1 tends to be more bold in men than in women, it should be noted that the degree of boldness of courtship-related consumption can vary for both men and women (e.g., women may require boldness to wear sexy clothes, whereas men may not require boldness to wear an expensive watch). Therefore, mating confidence might moderate the association between digit ratios and courtship-related behavior when the behaviors are bold in both men and women. Overall, these findings highlight the importance of considering trait variables as potential moderating factors in future digit ratio research, particularly since moderators are rarely investigated in this field.

Beyond the theoretical implications of our findings, we foresee a potential future practical implication. Companies are increasingly using biometrics for identification purposes since biometrics are difficult to emulate (Goode, 2014; Liu & Silverman, 2001). Examples of biometrics used for security purposes are fingerprint, hand, retina, facial and vocal characteristics. Biometric identification can be used to increase the accuracy of individually tailored marketing strategies (Jones, Williams, Hillier, & Comfort, 2007; Pons, 2006). In other words, by identifying individuals with biometric markers, practitioners can be certain to target the right consumers in their advertising campaigns. Our research suggests that biometrics might not only be used for increasing identification and targeting accuracy, but also be used for segmentation purposes. Specifically, practitioners might be able to scan consumer hands to segment and target them according to their digit ratio. For instance, a biometric device on a shopping cart (Angell & Kraemer, 2007) might be able to scan consumers' hands to identify a female consumer with feminized digit ratio and provide her with a promotion on jewelry. However, marketers must consider consumer privacy and legal issues involved in using biometric segmentation (Jones, Williams, Hillier, & Comfort, 2007; Pons, 2006).

In addition to its theoretical and potential practical implications, our paper also makes a methodological contribution to digit ratio research. Specifically, we find that *rel*2 performs better than 2D:4D in terms of the strength and number of statistically significant correlations in Study 2. This finding is consistent with Stenstrom et al. (2011) who found that *rel*2 yielded stronger correlations with men's risk-taking proclivities than 2D:4D. However, the results of Study 1 were more equivocal in terms of establishing which digit ratio metric is superior. Overall, future researchers might benefit from measuring both *rel*2 and 2D:4D especially given that these multiple measures are so easy and costless to collect.

Another potential future research avenue is to investigate if other traits that have been linked to prenatal testosterone might be relevant within consumer contexts. Given that prenatal testosterone has been shown to influence not only mating (Manning & Fink, 2008), but also gender identity (Csathó et al., 2003), and athletic performance (Manning & Taylor, 2001; Paul et al., 2006), we would expect digit ratios to be associated with consumption behaviors within these contexts. For instance, future research could investigate associations between digit ratios and preferences for sports-related products or gendered toys.

The current research adds to the growing evidence demonstrating the powerful effect that morphological features can wield across widely disparate settings including facial features and occupational success (Mueller & Mazur, 1996; Rule & Ambady, 2008), height and occupational success (Judge & Cable, 2004), facial features and aggressive sports behaviors (Carré & McCormick, 2008), men's good looks and sperm quality (Soler et al., 2003), and women's waist to hip ratios and their fertility (Singh, 2002) and sexual behavior (Hughes & Gallup, 2003). Investigating how these types of morphological features might be predictive of consumer behavior and decision-making may lead to novel insights regarding biological influences on consumer behavior.

Appendix A. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.jcps.2015.05.007.

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