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## Prenatal exposure to sex hormones predicts gratitude intervention use. Examination of digit ratio, motivational beliefs, and online activities



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### ABSTRACT

Men are less grateful than women and less likely to intentionally enhance gratitude via interventions. Yet, little is known if sex differences in gratitude result from biological influences such as prenatal testosterone and estrogen levels – hormones that control the development of sex-specific characteristics. In two studies, we examined how sex and second-to-fourth digit ratio (2D:4D) – an indicator of prenatal sex hormones exposure – predicts gratitude intervention use. In the first study, we tested whether lower 2D:4D (i.e., higher masculinization) would suppress gratitude intervention use. Contrary to expectations, after controlling for sex, women and men with more male-type fingers were more motivated and likely to complete the intervention. In the second study, we replicated these findings using a larger sample and different 2D:4D metric. Our research suggests that motivation towards gratitude interventions is facilitated by female sex and masculinity. These findings provide initial evidence for the biological grounding of individual differences in gratitude behavior.

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Men are generally less grateful than women and endorse greater difficulties expressing gratitude; with small to medium effect sizes of these phenomena (Kashdan, Mishra, Breen, & Froh, 2009). Furthermore, men perceive self-administered gratitude interventions to be more difficult to perform (Kaczmarek, Kashdan, Drążkowski, Bujacz, & Goodman, 2014). Yet, little is known about the extent to which sex differences in gratitude expression stem from biological factors such as exposure of the fetus to testosterone and estrogen. Prenatal hormones that control the development of sex-specific characteristics are among the first influences in ontogenesis that contribute to differences in psychological and behavioral outcomes observed in later life (MacLusky, Bowlby, Brown, Peterson, & Hochberg, 1997; Manning, 2011). We extended prior studies on gratitude interventions (Huffman et al., 2014; Kaczmarek, Kashdan, et al., 2014) by examining potential biological antecedents of the motivation to expand opportunities for greater gratitude experiences and expression. Understanding why individuals endorse or reject opportunities to become more grateful is vital for the provision of individually tailored health services.

### 1. Gratitude interventions

Grateful feelings result from the belief that one has obtained a benefit attributable to the actions of another person or some impersonal source (McCullough, Emmons, & Tsang, 2002). Although some gratitude interventions encourage people to thank benefactors in their lives (Lambert & Fincham, 2011), these interpersonal exchanges are often viewed as burdensome (Huffman et al., 2014). For this study, we used an intervention that required people to recognize and express beneficial daily experiences in a journal (Emmons & McCullough, 2003).

Only a fraction of individuals who are given an opportunity to initiate a free gratitude intervention program translate their intentions into practice (Kaczmarek et al., 2013). Yet, individuals with high intentions to change are about twice as likely to initiate a gratitude intervention successfully. High intenders derive their motivation from beliefs about the intervention's personal usefulness (utility beliefs), sense of approval from others upon attending to gratitude (social norm beliefs), and to a lesser extent – from the perceived feasibility/difficulty of the intervention (self-control beliefs; Kaczmarek, Kashdan, et al., 2014). These three motivational components, based on the theory of planned behavior (TPB; Ajzen, 1991, 2011), provide a useful framework for the study of self-motivated gratitude exercises.

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## 2. Sex differences in gratitude

Previous studies revealed that compared with men, women are more motivated to participate in gratitude interventions because they expect gratitude expression to be more useful and socially desirable (Kaczmarek, Kashdan, et al., 2014; Kaczmarek et al., 2015). This finding complements general evidence that women are more likely to feel and express gratitude and derive more benefits from gratitude expression (Kashdan et al., 2009). The early emergence of sex differences in gratitude expression and its stability across the life-span (Becker & Smenner, 1986; Krause, 2006) suggest that sex differences might be initiated by biological factors and not just social influences.

## 3. Second-to-fourth digit ratio

Understanding the long-term psychological consequences of prenatal exposure to sex hormones (testosterone and estrogen) became feasible after second (index finger) to fourth digit (ring finger) length ratios (2D:4D) received validation as an indicator of early hormonal influences (Manning, Scutt, Wilson, & Lewis-Jones, 1998). Resulting 2D:4D arises from variation in the length of the fourth digit that is particularly rich in androgen and estrogen receptors and thus more sensitive to influences from these hormones (Zheng & Cohn, 2011). Noteworthy, 2D:4D is unrelated to adult sex hormones levels (Hönekopp, Bartholdt, Beier, & Liebert, 2007).

Several studies indicated that lower 2D:4D is predictive of masculine psychological outcomes. Experimental studies with mammals reveal that lower 2D:4D results from stronger masculinization and defeminization prenatal processes (i.e., exposure to higher levels of prenatal testosterone relative to estrogen; Zheng & Cohn, 2011). For instance, girls with low 2D:4D show less preference for female-typical toys (e.g., baby dolls) and are more active during play (Alexander & Saenz, 2012), whereas boys show more preference for male-type plays (e.g., play-fighting, ball games) (Hönekopp & Thierfelder, 2009). Women with low 2D:4D tend to identify with male-type sex roles (Csathó et al., 2003), whereas men tend to be more dominating (Meij, Almela, Buunk, Dubbs, & Salvador, 2012) risk-taking (Stenstrom, Saad, Nepomuceno, & Mendenhall, 2011), and sensation-seeking (Fink, Neave, Laughton, & Manning, 2006). Despite these findings, a meta-analysis indicated that the correlations between 2D:4D and masculinity/femininity personality dimensions are not robust and 2D:4D explains only a small fraction of variance (Voracek, Pietschnig, Nader, & Stieger, 2011).

## 4. The present study

We examined whether 2D:4D predicts motivation in and actual performance of a self-initiated gratitude intervention. Based on prior studies (Kaczmarek et al., 2013; Kaczmarek, Goodman, et al., 2014) we examined whether women, and in particular women exposed to lower prenatal androgen levels (higher 2D:4D) show greater participation in gratitude interventions. We expected less masculinized (higher 2D:4D) men and more feminized women to be more likely to initiate a gratitude intervention. Furthermore, we expected behavioral intentions to be enhanced by higher utility beliefs and more accepting social-norm beliefs. These motivational beliefs were hypothesized to mediate between sex and 2D:4D and actual intervention participation. Accounting for markers of biological formative influences (2D:4D), in addition to sex of the participant (reflecting a compound of biological and social influences), allows for a better understanding of how individual differences affect gratitude expression.

## 5. Study 1

### 5.1. Participants

Participants were 279 undergraduates from natural science, life science, and technical departments (71% female) between the ages 18 and 28 years ( $M = 21.19$ ,  $SD = 1.71$ ). Students were recruited before classes by experimenters to a study on well-being. Volunteers received no incentives for their participation. Missing values (0.6%) were determined to be random, Little's test  $\chi^2(50) = 49.32$ ,  $p > .05$ , and imputed with Expectation–Maximization method (Enders, 2001). Written informed consent was obtained from each participant.

### 5.2. Procedure

Having read leaflets about the gratitude intervention, participants reported utility beliefs, social norm beliefs, and self-control beliefs regarding this intervention. They were informed that if they provided their e-mail address they could receive an online invitation for a free intervention. Next, we measured behavioral intentions towards the intervention and took photos of their hands with digital cameras. The invitation with the link to the intervention website was e-mailed the next day, and follow-up reminders were sent three days after completion of each entry.

### 5.3. Measures

We used four scales to measure utility, social norm, self-control beliefs, and behavioral intentions scales formulated according to guidelines provided by theory of planned behavior (TPB) and validated in prior studies (Kaczmarek, Goodman, et al., 2014; Kaczmarek, Kashdan, et al., 2014).

*Utility beliefs*, or attitudes about likely consequences of the gratitude intervention, were assessed with three items on a 7-point bipolar evaluative adjective scale: “unpleasant–pleasant”, “bad–good”, and “useless–useful” ( $\alpha = .83$ ).

*Social norm beliefs*, or beliefs about what significant others might think about participating in the intervention, were assessed with three items, e.g., “Most people who matter to me would approve my doing this intervention.” Participants responded to items on a 7-point scale from 1 = “completely disagree” to 7 = “completely agree” ( $\alpha = .89$ ).

*Self-control beliefs*, or beliefs about being able to effectively handle the intervention exercises, were measured with three items, e.g., “Performing this intervention would be very easy for me.” Participants responded to items on 7-point scale from 1 = “completely disagree” to 7 = “completely agree” ( $\alpha = .92$ ).

*Behavioral intentions* were assessed with three items about specific actions in the intervention. Preceded by the phrase “I intend to...” items included the following actions: “try out this activity”, “start this activity”, and “practice this activity”. Participants responded to items on 7-point scale from 1 = “completely disagree” to 7 = “completely agree” ( $\alpha = .95$ ).

*Behavior*: A value of 1 was assigned to those participants who completed a daily entry as logged by the intervention application, and a value of 0 was assigned if no Internet activity was observed.

*Digit ratio*: We used digital photos of the right hand (Hönekopp & Watson, 2010) in a resolution of 3072 × 2304 pixel to measure length of the index and the ring finger using the GNU Image Manipulation Program (GIMP) and its “measure” tool. Ratios were calculated by dividing the length, in pixels, of the second digit by the length of the fourth digit. The measurements performed by three independent raters were very reliable as indicated by the

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