Kiel
Working Papers

Kiel Institute
for the World Economy

Prenatal Testosterone Exposure Predicts Mindfulness - Does This Mediate Its Effect On Happiness?

by

Levent Neyse, Patrick Ring,
Steven Bosworth

No. 1999| April 2015

Prenatal testosterone exposure predicts mindfulness – Does this mediate its effect on happiness?

Levent Neyse[1], Patrick Ring[1,2] & Steven Bosworth[1]

Kiel Institute for the World Economy, Germany

Institute of Psychology, University of Kiel, Germany

ABSTRACT

This study investigates the connection between mindfulness and prenatal testosterone exposure and explores whether this is related to the relationship between mindfulness and human well-being as captured by three separate measures. In a sample of 90 German student participants, we find that subjects' digit ratio – a reliable indicator for exposure to prenatal testosterone – predicts their Mindful Attention Awareness Scale (MAAS) scores. Respondents with moderate levels of testosterone exposure have the highest MAAS scores. We additionally elicit participants' self-reported general life satisfaction and current happiness levels as well as their estimates about others' general life satisfaction. We find that MAAS strongly predicts absolute and relative life satisfaction and also current happiness levels, but digit ratios do not mediate the relationship between human well-being and mindfulness.

Keywords: *Mindfulness*; *Digit ratio (2D:4D)*; *Prenatal Testosterone*; *Life Satisfaction*; *Happiness*

Introduction

The concept of mindfulness refers to people's ability to make themselves aware of the present moment (Brown and Ryan, 2003; Brown et al., 2007). This ability requires on-going attention to both external and internal processes, but refrains from any judgment (Kabat-Zinn, 1994). A lack of mindfulness might lead to automatic behavior, i.e. behavior that ignores details relevant to present circumstances. While automatic behavior is efficient in familiar situations due to capacity savings, it might be inappropriate for new situations (Hollis-Walker and Colosimo, 2011).

The aim of our study is to determine if mindfulness is related to biological characteristics. In particular, prenatal exposure to testosterone or fetal testosterone (FT) has been reported to be influential on the brain development of human fetuses as well as the other mammals (Manning et al., 1998). The method called digit ratio (DR) is an indirect technique to predict someone's level of exposure to testosterone during the first trimester of gestation. It is calculated simply by dividing the length of index finger (2d) to the ring finger (4d). This ratio is negatively correlated to FT exposure; meaning that individuals with a low digit ratio are considered to have been exposed to high levels of testosterone. Lutchmaya et al. (2004) demonstrate direct evidence for a negative relationship between DR and fetal testosterone levels relative to fetal estradiol by analyzing the amniotic fluids of mothers in the second trimester of their pregnancy. The measured DR of their infants at 2 years of age is indeed negatively correlated with FT.

Research has indicated that FT predicts numerous diseases and somatic traits. Previous studies, for instance, have shown relationships between DR and autism (Manning et al., 2001); luteinizing hormone, prolactin, and sperm counts in men (Manning et al., 1998), and also impaired fetal growth (Ronalds et al., 2002). Due to its impact on brain development, FT has also been associated with numerous personality traits, cognitive, physical and social skills. These studies have focused especially on aggression (Bailey and Hurd, 2005; Perciavelle et al., 2013; Butovskaya et al., 2015)[1], dominance and masculinity (Neave et al., 2003). There is also a body of literature on the relationship between FT and sensation seeking, yet there is no consensus about the direction of either FT or gender's effect (See Voracek, 2010 for a meta-analysis). Millet and Dewitte (2008) and Millet (2009) point out that individuals with low DR have a higher need for achievement; which may explain extant findings on attainment in sports (Manning and Taylor 2001, Hönekopp et al., 2006, Tamiya et al. 2012), in music (Sluming and Manning, 2000) or as Millet himself suggests in financial success as reported in Coates et al. (2009). Indeed, economists find a highly negative relationship between FT and risk aversion (Stenstrom et al., 2011; Garbarino et al., 2011; Brañas-Garza and Rustichini, 2011), delay discounting (Lucas and Koff 2010) and profit maximizing preferences in economics experiments (Buser, 2012). Millet (2011) also reviewed the relationship between DR and economic decision making and points out the context dependency of the findings in the literature. As in these other studies, our aim is to better understand the biological processes underlying an important dimension of human psychology – here mindfulness. This knowledge can potentially shed light on the link between mindfulness and other personality characteristics. An an example application, we explore the link between mindfulness and life satisfaction in the paper's penultimate section.

We observe a significant relationship between Mindful Awareness Attention Scale (MAAS) scores and subjects' right hand DR. Specifically, those with moderate right-hand DR are strongly predicted to have higher MAAS scores (that is, a non-linear relationship). We also attempt to extend this finding with a natural application. Specifically, we ask whether our observed relationship between FT (as proxied by the right hand DR) can account for the well-established

[1] See Hönekopp & Watson, 2011 for a meta-analysis of the relationship between DR and aggression.

correlation between mindfulness and happiness or life satisfaction. Our subjects' MAAS scores strongly predict not only their absolute life satisfaction and happiness, but also their perceived life satisfaction relative to others – as expected. We do not find however that the relationship between prenatal testosterone exposure and mindfulness mediates the relationship between mindfulness and happiness. That is, inclusion of DR in regressions of happiness on mindfulness does not show a significant direct effect of FT on happiness, nor is the estimated coefficient of happiness on mindfulness significantly affected. The remainder of the paper is organized as follows: The next section describes the methods and procedures, then we present the results on MAAS scores and DR, which is followed by the application of the results on life satisfaction and happiness questions then we conclude.

Methods

Participants

We recruited 46 men and 44 women (N=90, mean age=23.8). All participants were students and received a monetary compensation for their participation. The level of compensation including a show-up fee of 2.5 Euro and earning from an unrelated economic task was on average 9.2 Euro. One participant was excluded from the analysis due to incomplete information on the MAAS.[2]

Procedure

The experiment was organized and recruited with the software hroot (Bock et al., 2012). Participants met in groups of 15 and were randomly assigned to seats in a classroom. At the beginning of the experiment, participants were given general instructions about the experimental procedure, which were followed by self-report questionnaires. Subsequently, they received instructions for an economic task. After the experiment, participants were invited one by one to a separate room for receiving their payment and scanning of their both hands.

Measures

All questionnaires reported in this article were conducted using pen and paper and were self-report measurements scored on Likert-type scales.

Mindfulness

Mindfulness levels were assessed using the Mindful Attention Awareness Scale (MAAS; Brown and Ryan, 2003). The MAAS is a 15-item scale assessing the occurrence of mindful states. Both everyday and specific situations are considered. Each item's scale ranges from 1 to 6. We calculate an overall mindfulness score for each participant by averaging these 15 items. Higher scores on the MAAS indicate greater mindfulness.

[2] All remaining participants were Caucasians. It is a common procedure to restrict the sample to one ethnicity in digit ratio analyses to reduce variance. Manning (2002) explains the ethnic variability of DR.

Happiness, own life satisfaction and relative life satisfaction

Happiness and own life satisfaction scores were obtained using questions from the World Values Survey[3] and range from 1 to 10 (*happiness:* "Taking all things together, how happy are you these days?"; *own life satisfaction*: "Generally speaking, how satisfied are you with your life as a whole these days?"). Higher scores indicate higher levels of happiness and life satisfaction. Similarly, the estimated life satisfaction of other people was elicited (*life satisfaction of other people*: "Generally speaking, how satisfied do you think other people are?"). We calculate relative life satisfaction scores by taking the difference between a participant's own life satisfaction and her estimate about other people's life satisfaction.

Digit Ratio

Following common recommendations (Neyse and Brañas-Garza, 2014), both hands were scanned with a high-resolution scanner (Epson V370 Photo). To determine 2D:4D, we measured the lengths of the index and ring digits on both hands from basal crease to the finger tip.

Results

Mindfulness and Digit Ratio

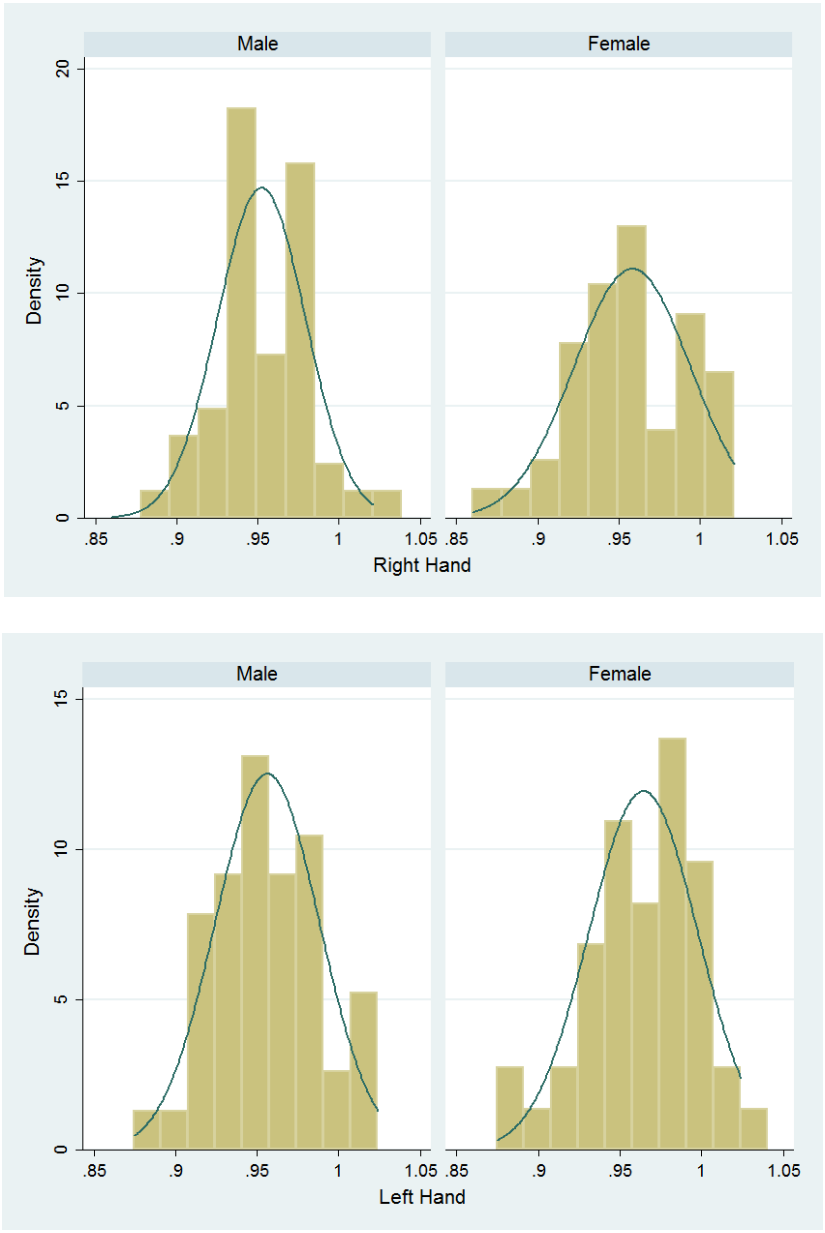
The average MAAS among experiment participants is *3.871* (*SD=.616*); and we do not observe any gender effects (Mann-Whitney *p=.274, z=1.093*). DR on the other hand is higher for women in line with the previous findings in the literature. Mean right-DR is *.958* (SD= *.035*) for women and *.952* (*.027*) for men where for left-DR it is *.964* (SD=*.033*) for women and *.956* (SD= *.031*) for men (see Figure 1). Although the *t*-test does not show a significant gender difference for either of the hands (*p=.1903* for the right, *p=.1223* for the left); the effects sizes (Cohen's d) are -*.1869* for the right hand and -*.2469* for the left. Furthermore, gender differences in DR are known to vary across nations (Manning et al., 2014) and subject pools[4].

Table 1 presents a regression analysis of mindfulness on DR. One participant with a right hand injury was excluded from the right hand analysis. In the regression, the composite *MAAS* score is the dependent variable. The minimum composite score in the whole sample is *2.4* and the maximum is *5.6*. Explanatory variables are *DR*, *DR2* (square of *DR* for the quadratic model) and *female,* dummy variable for gender. In addition to *age*, we also include *age2* (square of *age* for the quadratic model) as a standard control variable. DR is sexually dimorphic; thus we added an interaction variable, *femxdr*, to distinguish the gender effect from the DR effect. All regressions are Ordinary Least Squares models and *p-values* are given in the parentheses. The left three columns are devoted to right hand DR analysis and the right three columns to the left hand DR. The vast majority of the findings in the literature were obtained from the right hand ratio;

[3] http://www.worldvaluessurvey.org/wvs.jsp
[4] See Hönekopp and Watson (2010) for a meta-analysis on gender effects in digit ratio studies.

therefore, numerous studies only focus on the right hands. We present the left hand DR results here for completeness.[5]

Figure 1: Right and Left DR by Gender



[5] See Table A1 in the appendix for ordered probit models.

Although the negative sign of *DR* is in line with the majority of the literature, it is not significant in the first (linear) model. Thus we cannot argue that there is a monotonic relationship between DR and MAAS scores. The second, quadratic model on the other hand, shows that the link between DR and MAAS is significant and non-monotonic. Both *DR* and *DR2* are significant at the *.05* level in this model. This relationship has an inverted U-shape as the coefficient on *DR2* (*coeff: -92.026*) has a negative sign. We do not observe any gender effects either with (column 3) or without (column 2) an interaction term with DR (*p-values* are *.448* and *.389* respectively).

Table 1: Regression Table of MAAS and Digit Ratio

	Right Hand			Left Hand		
	(1)	(2)	(3)	(4)	(5)	(6)
DR	-1.211	**173.930**	**178.995**	-.201	.945	-.674
	(.546)	**(.041)**	**(.037)**	(.917)	(.992)	(.994)
DR2	--	**-92.026**	**-93.459**	--	-.600	-.079
	--	**(.040)**	**(.037)**	--	(.990)	(.999)
female	-.147	-.096	3.438	-.172	-.172	-1.335
	(.247)	(.448)	(.389)	(.179)	(.183)	(.725)
femxdr	--		-3.696	--	--	1.209
	--		(.375)	--	--	(.759)
age	-.101	-.112	-.089	-.093	-.093	-.096
	(.298)	(.238)	(.363)	(.341)	(.345)	(.333)
age2	.002	.002	.002	.002	.002	0.002
	(.117)	(.093)	(.159)	(.133)	(.136)	(.132)
cons	**6.123**	-76.941	**-80.810**	**5.018**	4.472	5.598
	(.015)	(.057)	**(.047)**	**(.036)**	(.920)	(.901)
N	88	88	88	89	89	89
R2	.1308	.1747	.1827	.1309	.1309	.1319

Note: All OLS models. Dependent variable is *MAAS*; *p*-values are indicated in brackets. Independent variables are *DR* for digit ratio, *DR2* is the square of DR, female dummy is 1 for women, *femxdr* is the interaction variable for DR and gender. The first three models use the right hand DR and the remaining three use the left. Recall that one subject with a right hand injury was excluded.

We do not find any linear or non-linear effects of the left hand DR on mindfulness. Both *DR* and *DR2* are insignificant in the right three columns. A large majority of the findings in DR studies are typically due to right hand ratios (see Hönekopp and Watson, 2010).

Application: Mindfulness and Life Satisfaction

In recent years, empirical studies have conclusively established a positive correlation between mindfulness and human well-being (e.g. Brown et al., 2009). Moreover, intervention studies support a causal link between them, in particular that an increase in mindfulness tends to lead to an increase in human well-being (Falkenström, 2010; Fredrickson et al., 2008). Although the underlying mechanisms of the identified causality have not been analyzed in a systematic way, it has been proposed that mindfulness supports not only the awareness of one's own emotions, but also motivates behavior that encourages positive emotions (Wang and Kong, 2014).

Research on human well-being is well established in the social sciences. People's well-being is usually assessed via standard self-report measures on questionnaires, foremost among them those of the widely studied World Values Survey (Kahneman and Krueger, 2006). The psychological aspects of human well-being are relatively well understood, with a number of stylized facts supporting convergent theorizing.

Both happiness and life satisfaction are influenced by a number of stable demographic and personality-based factors, but also by very transitory circumstances (Schwarz and Clore, 1983; Schwarz and Strack, 1991). Happiness' susceptibility to such influences could explain why the test-retest reliability of life satisfaction measures are so low (Kahneman and Krueger, 2006). Kahneman and Krueger also note the "prominent role played by attention or cognitive focus on particular aspects of a situation".

A number of stable personality characteristics are known to be associated with human well-being. The twin study of Lykken and Tellegen (1996) suggests that life satisfaction may be heritable. Lyubomirsky and Tucker (1998) find that subjects who report higher baseline happiness interpret the same events and stimuli in a more positive light. Post (2005) also finds that more altruistic people are happier, so long as they are not "overwhelmed" by their desire to help.

Our study investigates the relationship between mindfulness and three separate measures of human well-being in our sample. In addition to general human well-being measured as self-reported happiness and life satisfaction, we also analyze relative life satisfaction, i.e. the difference between one's one self-reported level of life satisfaction and one's estimate about other peoples' level of life satisfaction.

Results

The average life satisfaction of the participants is *7.06* (*SD=1.63*) while they report their current happiness level as being *6.67* (SD=*1.80*). On average subjects predict that other people's life satisfaction level is *6.72* (SD=*1.28*). An unpaired *t*-test rejects the null hypothesis of equal variances at the *6%* level (*t=1.5234*), meaning that on average participants tend to report their life satisfaction as being higher than others'. We compute an additional measure, relative life satisfaction, as the difference between self-reported life satisfaction and predicted life satisfaction of others. The mean of relative life satisfaction is .33 (SD= *1.55*) (See Figure 2).

Figure 2: Histograms of Well Being Variables

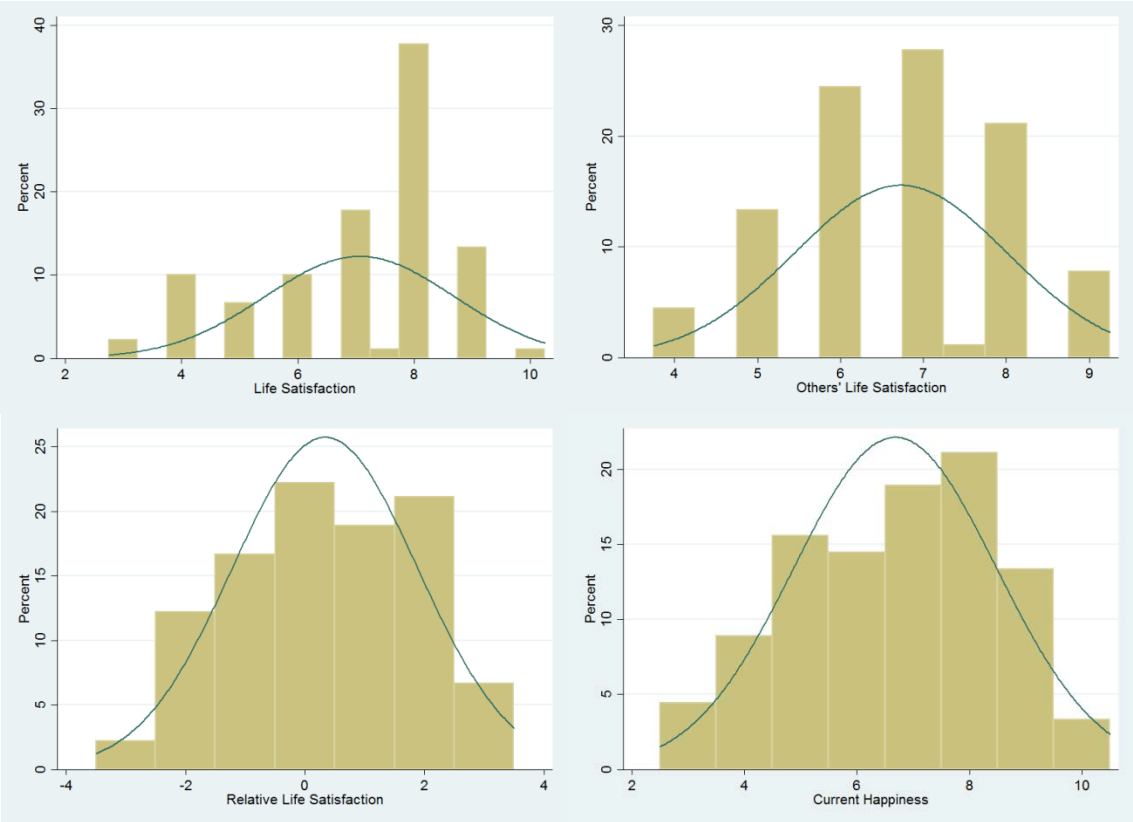


Table 2 presents OLS regressions where the dependent variable is life satisfaction (*life_sat_i*) in the first column, others' life satisfaction (*life_sat_j*) in the second, relative life satisfaction (*rel_life_sat*) in third and finally current happiness level (*happy*) in fourth. The explanatory

variables are *MAAS scores, age, age squared* and an indicatory for female, as described in the previous regression analysis.[6]

Table 2: Regression Table of Mindfulness and Happiness Variables

	life_sat_i		life_sat_j		rel_life_sat		happy	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
MAAS	**1.049**	**.902**	.260	.178	**.788**	**.724**	**1.244**	**1.062**
	(.000)	**(.003)**	(.266)	(.469)	**(.005)**	**(.012)**	**(.000)**	**(.002)**
rDR	--	98.992	--	164.927	--	-65.934	--	348.477
	--	(.664)	--	(.390)	--	(.764)	--	(.173)
rDR2	--	-52.904	--	-89.201	--	36.296	--	-181.992
	--	(.659)	--	(.376)	--	(.753)	--	(.175)
age	-.294	-.338	.207	.177	**-.502**	**-.515**	-.120	-.173
	(.250)	(-.338)	(.323)	(.405)	**(.042)**	**(.037)**	(.670)	(.538)
age2	.002	.003	-.004	-.004	.007	**.007**	.001	.001
	(.462)	(.364)	(.176)	(.220)	(.055)	**(.046)**	(.878)	(.729)
female	.268	.357	.009	.082	.258	.274	.358	.479
	(.422)	(.289)	(.972)	(.768)	(.419)	(.397)	(.334)	(.202)
cons	8.136	-36.869	3.364	-71.893	4.772	35.023	4.153	-161.037
	(.047)	(.733)	(.315)	(.428)	(.221)	(.736)	(.357)	(.183)
N	89	88	89	88	89	88	89	88
Pseudo R2	.1312	.1640	.0613	.0825	.1531	.1525	.1658	.1726

Note: All OLS models. Dependent variables are: *life_sat_i* individual life satisfaction, *life_sat_j* life satisfaction of other people, *rel_life_sat* stands for relative life satisfaction and *happy* for current happiness level. p-values are given in the brackets.

[6] See Table A2 in the appendix for ordered probit models.

The results show that MAAS scores have a strong positive effect on all of the three happiness measures ($p \leq .01$) in all columns except for (3) and (4) (*life_sat_j*). However, we do not find any direct results with others' life satisfaction variable or the control variables. Furthermore, in comparing regressions of happiness measures on *MAAS* with and without controls for *DR*, we do not find any significant differences in the coefficient on *MAAS*. Thus, we find no evidence that prenatal testosterone exposure significantly mediates the relationship between happiness and mindfulness. Among the control variables, *age* and *age2* are significant at 5% level at columns (5) and (6), which can be interpreted as, in the current sample, relative life satisfaction decreases while age is increasing and non-monotonic (*coeff= .007*).

Discussion

The present study investigated the relationship between mindfulness and prenatal testosterone exposure, and examined whether this might lie behind the connection between mindfulness and human well-being.

Our first finding indicates that respondents with moderate levels of testosterone exposure have the highest MAAS scores. Alongside the inverse correlations dominating the DR literature among different fields, experimental evidences on social interactions and several cognitive skills indicate non-monotonic impacts on altruism (Brañas et al., 2013; Galizzi and Nieboer, 2015), cooperation (Sanchez-Pages and Turiegano, 2010) and also on academic performance (Nye et al., 2012). Non-monotonic results such these constitute support for stabilizing selection, which is a type of natural selection that favors the median values instead of the edges of the distribution. Therefore, individuals with a DR around the median of the sample may show different patterns of behavior and skills than the tails of the distribution. As observed in the social dilemma experiments cited above, those with moderate FT may have higher tendency to comply with social norms, which can be thought of as a survival ability given human beings' social nature. Brañas-Garza et al. (2013) discuss this in detail.

We document a biological underpinning of mindfulness and ask whether this might be applied in explaining its role in predicting other personliaty traits and preferences. As an example, we study both absolute and relative life satisfaction. Of course we do not claim that prenatal testosterone is the only determinant of mindfulness, or that mindfulness is completely biologically determined. Numerous studies examining interventions training people to be more mindful have found a number of effects (see, Baer, 2003 for a review). Such interventions may be particularly important for those predisposed to be low in mindfulness. Our study identifies one such marker.

We also show that there is a positive relation between MAAS and both absolute and relative life satisfaction. This finding indicates that people with higher MAAS not only tend to be more satisfied with their lives, but they also tend to think that they are more satisfied than their peers. This finding appears in line with the idea that mindfulness increases peoples' awareness of the external world and thereby changes their perception as well (Brown, Ryan and Creswell, 2007).

This second result does not appear connect to the first, however, meaning that the role of mindfulness in promoting happiness does not involve prenatal testosterone as an underlying mechanism. More research on the deeper foundations of mindfulness and well-being is thus called for.

Acknowledgements

Authors thank Ulrich Schmidt and Pablo Brañas-Garza for their valuable comments and Kiel Institute for the World Economy for financial support.

References

Bailey, A. A., & Hurd, P. L. (2005). Finger length ratio (2D: 4D) correlates with physical aggression in men but not in women. Biological Psychology, 68(3), 215-222.

Baer, R. A., (2003). Mindfulness training as a clinical intervention: A conceptual and empirical review. Clinical Psychology: Science and Practice, 10(2), 125-143.

Bock, O., Baetge, I., & Nicklisch, A. (2014). hroot: Hamburg registration and organization online tool. European Economic Review, 71, 117-120.

Brañas-Garza, P., & Rustichini, A. (2011). Organizing effects of testosterone and economic behavior: Not just risk taking. PloS one, 6(12), e29842.

Brañas-Garza, P., Kovářík, J., & Neyse, L. (2013). Second-to-fourth digit ratio has a non-monotonic impact on altruism. PloS one, 8(4), e60419.

Brown, K. W., & Ryan, R. M. (2003). The benefits of being present: mindfulness and its role in psychological well-being. Journal of Personality and Social Psychology, 84(4), 822-848.

Brown, K. W., Kasser, T., Ryan, R. M., Linley, P. A., & Orzech, K. (2009). When what one has is enough: Mindfulness, financial desire discrepancy, and subjective well-being. Journal of Research in Personality, 43(5), 727-736.

Brown, K. W., Ryan, R. M., & Creswell, J. D. (2007). Mindfulness: Theoretical foundations and evidence for its salutary effects. Psychological Inquiry, 18(4), 211-237.

Buser, T. (2012). Digit ratios, the menstrual cycle and social preferences. Games and Economic Behavior, 76(2), 457-470.

Butovskaya, M., Burkova, V., Karelin, D., & Fink, B. (2015). Digit ratio (2D: 4D), aggression, and dominance in the Hadza and the Datoga of Tanzania. American Journal of Human Biology.

Coates, J. M., Gurnell, M., & Rustichini, A. (2009). Second-to-fourth digit ratio predicts success among high-frequency financial traders. Proceedings of the National Academy of Sciences, 106(2), 623-628.

Falkenström, F. (2010). Studying mindfulness in experienced meditators: A quasi-experimental approach. Personality and Individual Differences, 48(3), 305-310.

Fredrickson, B. L., Cohn, M. A., Coffey, K. A., Pek, J., & Finkel, S. M. (2008). Open hearts build lives: positive emotions, induced through loving-kindness meditation, build consequential personal resources. Journal of Personality and Social Psychology, 95(5), 1045-1062.

Galizzi, M. M., & Nieboer, J. (2015). Digit ratio (2D: 4D) and altruism: evidence from a large, multi-ethnic sample. Frontiers in Behavioral Neuroscience, 9(41).

Garbarino, E., Slonim, R., & Sydnor, J. (2011). Digit ratios (2D: 4D) as predictors of risky decision making for both sexes. Journal of Risk and Uncertainty, 42(1), 1-26.

Hollis-Walker, L., & Colosimo, K. (2011). Mindfulness, self-compassion, and happiness in non-meditators: A theoretical and empirical examination. Personality and Individual Differences, 50(2), 222-227.

Hönekopp, J., & Watson, S. (2010). Meta-analysis of digit ratio 2D: 4D shows greater sex difference in the right hand. American Journal of Human Biology, 22(5), 619-630.

Hönekopp, J., & Watson, S. (2011). Meta-analysis of the relationship between digit-ratio 2D: 4D and aggression. Personality and Individual Differences, 51(4), 381-386.

Hönekopp, J., Manning, J. T., & Müller, C. (2006). Digit ratio (2D: 4D) and physical fitness in males and females: Evidence for effects of prenatal androgens on sexually selected traits. Hormones and Behavior, 49(4), 545-549.

Kabat-Zinn, J. (1994). Wherever you go, there you are: Mindfulness meditation in everyday life. New York: Hyperion.

Kahneman, D. & Krueger, A. B. (2006). Developments in the measurement of subjective well-being. Journal of Economic Perspectives, 20(1), 3-24.

Lucas, M., & Koff, E. (2010). Delay discounting is associated with the 2D: 4D ratio in women but not men. Personality and Individual Differences, 48(2), 182-186.

Lutchmaya, S., Baron-Cohen, S., Raggatt, P., Knickmeyer, R., & Manning, J. T. (2004). 2nd to 4th digit ratios, fetal testosterone and estradiol. Early human development, 77(1), 23-28.

Lykken, D. T. & Tellegen, A. (1996). Happiness is a stochastic phenomenon. Psychological Science, 7(3), 186-189.

Lyubomirsky, S. & Tucker, K. L. (1998). Implications of individual differences in subjective happiness for perceiving, interpreting, and thinking about life events. Motivation and Emotion, 22(2), 155-186.

Manning, J. T., & Taylor, R. P. (2001). Second to fourth digit ratio and male ability in sport: implications for sexual selection in humans. Evolution and Human Behavior, 22(1), 61-69.

Manning, J. T., Baron-Cohen, S., Wheelwright, S., & Sanders, G. (2001). The 2nd to 4th digit ratio and autism. Developmental Medicine & Child Neurology, 43(3), 160-164.

Manning, J. T. (2002). Digit ratio: A pointer to fertility, behavior, and health. Rutgers University Press.

Manning, J. T., Scutt, D., Wilson, J., & Lewis-Jones, D. I. (1998). The ratio of 2nd to 4th digit length: a predictor of sperm numbers and concentrations of testosterone, luteinizing hormone and oestrogen. Human reproduction, 13(11), 3000-3004.

Manning, J. T., Fink, B. & Trivers, R. (2014). Digit ratio (2D:4D) and gender inequalities across nations. Evolutionary Psychology, 12 (4). pp. 757-768.

Millet, K. (2009). Low second-to-fourth-digit ratio might predict success among high-frequency financial traders because of a higher need for achievement. Proceedings of the National Academy of Sciences of the United States of America, 106(2), 623-628.

Millet, K. (2011). An interactionist perspective on the relation between 2D: 4D and behavior: An overview of (moderated) relationships between 2D: 4D and economic decision making. Personality and Individual Differences, 51(4), 397-401.

Millet, K., & Dewitte, S. (2008). A subordinate status position increases the present value of financial resources for low 2D: 4D men. American Journal of Human Biology, 20(1), 110-115.

Neave, N., Laing, S., Fink, B., & Manning, J. T. (2003). Second to fourth digit ratio, testosterone and perceived male dominance. Proceedings of the Royal Society of London. Series B: Biological Sciences, 270(1529), 2167-2172.

Neyse, L., & Brañas-Garza, P. (2014). Digit ratio measurement guide (No. 1914). Kiel Working Paper.

Nye, J. V., Androuschak, G., Desierto, D., Jones, G., & Yudkevich, M. (2012). 2D: 4D asymmetry and gender differences in academic performance. PloS one, 7(10), e46319.

Perciavalle, V., Di Corrado, D., Petralia, M. C., Gurrisi, L., Massimino, S., & Coco, M. (2013). The second-to-fourth digit ratio correlates with aggressive behavior in professional soccer players. Molecular Medicine Reports, 7(6), 1733-1738.

Post, S. G. (2005). Altruism, happiness, and health: It's good to be good. International Journal of Behavioral Medicine, 12(2), 66-77.

Ronalds, G., Phillips, D. I. W., Godfrey, K. M., & Manning, J. T. (2002). The ratio of second to fourth digit lengths: a marker of impaired fetal growth?. Early human development, 68(1), 21-26.

Sanchez-Pages, S., & Turiegano, E. (2010). Testosterone, facial symmetry and cooperation in the prisoners' dilemma. Physiology & Behavior, 99(3), 355-361.

Schwarz, N., & Strack, F. (1991). Evaluating one's life: A judgement model of subjective well-being. In: Subjective Well-Being: An Interdisciplinary Perspective, eds. F. Strack, M. Argyle & N. Schwarz, Oxford: Pergamon Press, pp. 27-47.

Schwarz, N., & Clore, G. L. (1983). Mood, misattribution, and judgments of well-being: Informative and directive functions of affective states. Journal of Personality and Social Psychology, 45(3), 513-523.

Sluming, V. A., & Manning, J. T. (2000). Second to fourth digit ratio in elite musicians: evidence for musical ability as an honest signal of male fitness. Evolution and Human Behavior, 21(1), 1-9.

Stenstrom, E., Saad, G., Nepomuceno, M. V., & Mendenhall, Z. (2011). Testosterone and domain-specific risk: Digit ratios (2D: 4D and rel2) as predictors of recreational, financial, and social risk-taking behaviors. Personality and Individual Differences, 51(4), 412-416.

Tamiya, R., Lee, S. Y., & Ohtake, F. (2012). Second to fourth digit ratio and the sporting success of sumo wrestlers. Evolution and Human Behavior, 33(2), 130-136.

Voracek, M., Tran, U. S., & Dressler, S. G. (2010). Digit ratio (2D: 4D) and sensation seeking: New data and meta-analysis. Personality and Individual Differences, 48(1), 72-77.

Wang, Y., & Kong, F. (2014) The role of emotional intelligence in the impact of mindfulness on life satisfaction and mental distress. Social Indicators Research, 116(3), 843-852.

APPENDIX

Table A1: Ordered Probit Regression Table of MAAS and Digit Ratio

	Right Hand			Left Hand		
	(1)	(2)	(3)	(4)	(5)	(6)
dr	-2.151	**303.002**	**312.815**	-.386	2.033	-1.979
	(.536)	**(.043)**	**(.038)**	(.907)	(.990)	(.990)
dr2	--	**-160.392**	**-163.536**	--	-1.266	-.067
	--	**(.042)**	**(.038)**	--	(.988)	(.999)
female	-.284	-.202	5.663	-.320	-.320	-3.547
	(.196)	(.365)	(.421)	(.144)	(.145)	(.584)
femxdr	--	--	-6.136	--	--	3.358
	--	--	(.405)	--	--	(.618)
age	-.423	-.445	-.404	-.410	-.410	-.435
	(.256)	(.226)	(.373)	(.274)	(.274)	(.283)
age2	.009	.009	.008	.009	.009	.009
	(.206)	(.187)	(.217)	(.216)	(.216)	(.231)
N	88	88	88	89	89	89
R2	.0246	.0318	.0330	.0247	.0247	.0251

Note: All Ordered Probit models. Dependent variable is *MAAS*; p-values are indicated in the brackets. Independent variables are *dr* for digit ratio, *dr2* is the square of dr, female dummy is 1 for women, *femxdr* is the interaction variable for digit ratio and gender. First three models are devoted for right hand regressions and rest for the left.

Table A2: Regression Table of Mindfulness and Happiness Variables

	life_sat_i		life_sat_j		rel_life_sat		happy	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
MAAS	**.710**	**.617**	.225	.158	**.578**	**.536**	**.766**	**.668**
	(.000)	**(.003)**	(.238)	(.428)	**(.003)**	**(.009)**	**(.000)**	**(.001)**
rDR	--	99.848	--	145.469	--	-29.093	--	208.479
	--	(.521)	--	(.352)	--	(.850)	--	(.177)
rDR2	--	-52.508	--	-78.537	--	16.636	--	-109.192
	--	(.521)	--	(.339)	--	(.838)	--	(.179)
age	-.090	-.130	.278	.253	-.486	-.516	-.074	.112
	(.602)	(.456)	(.216)	(.262)	(.077)	(.068)	(.660)	(.511)
age2	.001	.001	-.005	-.005	.008	.008	.001	.001
	(.913)	(.744)	(.145)	(.169)	(.117)	(.105)	(.893)	(.727)
female	.279	.350	.011	.075	.194	.221	.236	.322
	(.220)	(.133)	(.960)	(.744)	(.386)	(.334)	(.289)	(.159)
N	89	88	89	88	89	88	89	88
Pseudo R2	.0465	.0451	.0233	.0301	.0524	.0533	.046	.0478

Note: Ordered Probit Models. Dependent variables are: *life_sat_i* individual life satisfaction, *life_sat_j* other people Life Satisfaction of Other People, *rel_life_sat* stands for relative life satisfaction and *happy* for Current Happiness level. p-values are given in the brackets.