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Signature size signals sociable dominance and narcissism

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ABSTRACT

Handwritten signatures have been traditionally associated with personality traits. In this study, we examined the relationship of signature size with intrasexual competition, aggressive and sociable dominance, narcissism, and self-esteem in a sample of Uruguayan university students ($N = 340$). The study went methodologically beyond current research by examining three different operationalizations of signature size, and by controlling for potential confounders: number of characters in the printed name, average character area in the printed name—a proxy for overall writing size—, and signature style. After controlling for these potential confounders and demographic variables, our results showed a significant link between signature size and sociable dominance, both for males and females, while narcissism was only in females significantly associated with signature size.

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1. Introduction

Handwritten signatures have been considered for long to reflect motor behavior intimately related to deep-lying personality traits (e.g., Allport, Vernon, & Powers, 1933; Eisenberg & Reichline, 1939; Zweigenhaft & Marlowe, 1973). The alleged association between personality traits and handwriting did not go without criticism. Nearly a century ago, Hull and Montgomery (1919) argued that the correlation between different handwriting attributes and personality traits was practically nonexistent. Indeed, the few studies that have addressed the association between handwriting characteristics and personality traits, provide very weak to no evidence in support of the inferring power of graphology (Furnham & Gunter, 1987; King & Koehler, 2000; Klimoski & Rafaeli, 1983; Neter & Ben-Shakhar, 1989).

A few studies, instead of relying on the postulates of graphology, took a different approach and analyzed particular attributes of handwritten signatures in relation to personality traits. In a series of studies, Zweigenhaft (1970, 1977), Zweigenhaft and Marlowe (1973) observed that signature size was positively associated with status and self-esteem. Similar results were obtained by Swanson and Price (1972) in a related study; however, Mahoney (1973) failed to find significant associations between signature size and

self-estimation. In a similar vein, Jorgenson (1977) reported a positive correlation between signature size and dominance for women ($r = 0.45$, $p < 0.001$), but not for men ($r = 0.07$, ns). Recently, Ham, Seybert, and Wang (2013) reported a positive correlation between normalized signature size—i.e., signature area divided by the number of characters—and narcissism ($r = 0.45$, $p < 0.01$) in a sample of graduate business students. Furthermore, these authors observed that CEO normalized signature area was negatively correlated with firm performance—measured by return on assets (ROA)—and positively correlated with CEO compensation (Ham et al., 2013). Experimental evidence for the importance of signature size comes from a study by Rawal and co-workers who found that, following a positive-affect priming task, signature size increased relative to the non-affective control condition (Rawal, Harmer, Park, O'Sullivan, & Williams, 2014). Finally, it must be noted that a study by Dillon (1988) showed that women who embellished their signatures on a birthday card had significantly higher narcissism scores than women who did not; however, no association between narcissism and signature embellishment was observed for men.

There is also some evidence for effects of drawing one's signature on self-related behaviors. Kettle and Häubl (2011) observed that signing one's name can affect subsequent purchasing behaviors in domains close to one's self-identity, probably by prompting a stronger sense of self-identity. Similarly, it has been shown that signing at the beginning of a document—rather than at the end—decreases dishonest self-reports (Shu, Mazar, Gino, Ariely, & Bazerman, 2012) allegedly by activating attention to oneself, and

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thus making a person's moral concepts more salient. In a related study, *Chou (2015)* found that this effect is elicited by handwritten signatures and not by e-signatures, since the latter evoke a weaker sense of self-presence.

Some previous studies which reported an association between personality traits and signature size used rather small samples (e.g., *Ham et al., 2013; Swanson & Price, 1972; Zweigenhaft, 1970, 1977; Zweigenhaft & Marlowe, 1973*), or somewhat lax operationalizations of personality traits—e.g., some studies equated professional development to status or self-esteem (*Swanson & Price, 1972; Zweigenhaft & Marlowe, 1973*). In addition, most prior studies used a rather restricted approach to signature size analysis, i.e., they only included signatures matched for number of characters, or normalized signature areas—i.e., signature area divided number of characters included in the signature—thus limiting the sample to legible signatures (*Ham et al., 2013; Swanson & Price, 1972; Zweigenhaft, 1970, 1977; Zweigenhaft & Marlowe, 1973*). However, it should be noted that only a fraction of handwritten signatures are actually readable. *Mohammed, Found, and Rogers (2008)* observed that only 44.2% of males produced legible signatures, while 70.4% of women's signatures were readable. Furthermore, this bias in signature legibility was statistically significant (*Mohammed et al., 2008*). Thus, matching signatures by number of characters, or normalizing signature area by number of letters—which implies the use of fully readable signatures only—may fail to capture the full extent of the influence of sex on handwritten signatures, and thus interfere with the characterization of the association of signatures and personality traits.

Most previous studies, which explored the association of handwritten signatures and personality traits, analyzed the relationship of signature size with (social) status, self-esteem, dominance, and narcissism. This research aimed at furthering the study of the relationship of signature size and these personality traits. In addition, given that narcissism has been previously related to self-enhancement (*Grijalva & Zhang, 2015; Wallace, 2011*) and rival-derogation (*Goncalves & Campbell, 2014; South, Oltmanns, & Turkheimer, 2003*), and that these traits are reminiscent of intra-sexual competition strategies (*Buss, 1988; Buunk & Fisher, 2009; Fisher & Cox, 2011*), we also analyzed the potential link between this latter variable and signature size.

Based on the significance of handwritten signatures as representations of the self (*Chou, 2015; Kettle & Häubl, 2011; Shu et al., 2012*), and that a large signature can be seen as a sign of high self-esteem, and an inclination to dominate others, we hypothesized a positive association of signature size and the expansive personality traits considered in this study.

We tried to overcome methodological limitations of previous research in this area in several ways. First, we examined various measures of signature size. Size determination of complex shapes or bodies poses both theoretical and practical challenges. Following the pioneer work by *Zweigenhaft (1970)*, in psychological research, signature size has been traditionally measured as the area of the minimal rectangle, or bounding box—orthogonal to the page—which contains the handwritten signature. In addition to this method, we explored two additional operationalizations of signature size: the minimal rotated bounding box area, and the convex hull area (see *Fig. 1*).

A second way in which our study went, methodologically, beyond previous research was that we controlled for a number of potentially confounding variables, i.e., number of characters in printed name—an indicator of a person's name length—the average character area in the printed name—a proxy for overall writing size—and signature style (signatures based on monograms or initials vs extended signatures).

Finally, since signatures and printed names appear to differ in their ability to elicit self-feelings (*Kettle & Häubl, 2011*), we also

explored the association between the previously mentioned personality traits and the metrics of the participants' printed name.

2. Method

2.1. Participants

The sample consisted of male and female students enrolled in the Psychology degree at Universidad de la República, a large public university in Montevideo, Uruguay. All participants were native Spanish speakers, and all questionnaires were administered in Spanish. Since there are very few cross-sectional studies which examine the relationship between signature size and personality traits, and given that we hypothesized that if such associations existed, they would exhibit low to moderate effect sizes, we aimed for a minimum sample consisting of 150 males and 150 females. We allowed an excess of female participants since their data was easier to collect, provided that the male-to-female proportion was at least 3:4.

192 females, and 148 males, ages between 18 and 52 years ($M = 23.8$, $SD = 7.0$) returned the completed forms. 5 participants did not sign the forms, and an additional 5 participants did not provide a printed name, and were therefore excluded from some of the analyses. Some participants failed to answer one or more items from the different administered questionnaires; this explains why the number of participants slightly differs between the different analyses. Data analyses were not conducted until the data from all participants was collected. All procedures of the study were approved by the university's ethical review committee. Participants gave their informed written consent to participate in this study.

2.2. Signature and printed name metrics

Participants provided both their signatures and names in print on the consent form, which included half a page of blank space, so that no limitations on (normal) signature size were imposed.

Number of characters in printed names was assessed by visual inspection. Spaces—e.g. between name and surname—and periods were computed as characters, since they influence the total area of the printed name, and thus the average character area. Average character area was calculated by dividing the total area of the printed name (see below) by number of characters included.

Upon visual inspection of the signatures, two different signing styles were readily identified: signatures based on initials, monograms or paraphs; and extended signatures (text based, stylized text or mixed). Signatures were assigned to one of these categories by three independent researchers. When there was no consensus on signature classification, the signature style assigned by consensus. Inter-rater agreement for signature style was 92.7% with a Fleiss' kappa value of 0.85. A significant association between signature style and sex was observed: 25% of males versus 9% of females produced monogram-based signatures ($\chi^2 = 13.70$, $p < 0.001$).

Signatures and printed names were digitized at 300 dpi using a flatbed scanner (CanoScan LiDE 100 Canon Scanner). The resulting images were binarized into black and white images (desaturation by luminosity; threshold levels: 210, 255) using GIMP 2.8 software. The binary images were then visually inspected, and any observed speckles were individually removed. Subsequently, black and white images were processed with aid of GNU Octave software (<http://www.octave.org>). The features extracted for each signature and printed name were the bounding box area (area of the minimal rectangle—orthogonal to the page—containing the signature), and the convex hull area (area of the minimal convex shape containing the signature), (see *Fig. 1*). Following *Swanson and Price (1972)*,

Fig. 1. Signature area operationalizations. (a) Sample signature, (b) bounding box, (c) minimal rotated bounding box, (d) convex hull. Using as a reference the area of the bounding box, minimal rotated bounding box area equals 0.775, and convex hull area equals 0.562.

and attempting to minimize the skewness of the distribution, the square root transform of area measures was used in all subsequent analyses. Effectively, the Pearson skewness coefficient for signature size dropped from 6.6 to 2.56 after transformation.

Descriptive statistics for the different operationalizations of signature size are shown in Table 1. Following Hoaglin and Iglewicz (1987), we considered transformed area values lower than the first quartile minus 2.2 times the interquartile range, or higher than the third quartile plus 2.2 times the interquartile range or as outliers. Using this criterion, 6 individuals were removed from the analyses, and the skewness of the signature size distribution further dropped to 0.90. Of importance, the removal of these outliers did not substantially change regression results (data not shown).

2.3. Personality traits

Narcissistic personality was assessed using the reduced version of the Narcissistic Personality Inventory, NPI-16 (Ames, Rose, & Anderson, 2006). Since no Spanish version of this scale was available at the time the study was conducted, the items included in the NPI-16 were extracted from the Spanish version of the 40-item scale, NPI-40 (García Garduño & Cortés Sotres, 1998). Items 8 (*I always know what I am doing/Sometimes I am not sure of what I am doing*), and 13 (*I am going to be a great person/I hope I am going to be successful*) showed low or negative correlation scores with the total scale (0.016 and -0.020 , respectively), and were excluded from subsequent analyses. In subsequent analyses, the resulting 14 items scale is referred to as NPI. Similar results were obtained in the regression analyses when all items of the NPI-16 scale were used (data not shown).

Intrasexual competition was measured with the Spanish version of the Intrasexual Competition Scale (Buunk & Fisher, 2009; Buunk, Zurriaga, González, & Castro-Solano, 2012). Dominance was measured with the sociable and aggressive dominance scales, developed by Kalma, Visser, and Peeters (1993). We used a Spanish version of the scales, previously translated by the authors (Mailhos, Buunk, & del Arca, 2013). Self-esteem was assessed using the Spanish version of Rosenberg's global self-esteem scale (Rosenberg, 1965) developed by Atienza, Moreno, and Balaguer (2000). Descriptives for the different psychological variables included in this research are presented in Table 3. In the present study, all personality scales showed Cronbach's α s larger than 0.75, except for the NPI (Cronbach's $\alpha = 0.60$).

2.4. Statistical analyses

Two-step multiple hierarchical regression analyses were performed in order to assess the relationship between signature size and personality traits. In the first step, potential confounders (i.e., sex and age, number of characters in printed name, average character area—in printed name—and signature style) were entered into the regression equations to develop a null model. Null models provide a baseline upon which to assess the impact of predictor variables. Null models were constructed by performing forward step-wise regressions including the demographic variables (sex and age) and signature variables (number of characters in printed name, average character area in printed name, and signature style), and all their pair-wise interactions as predictors. The model with the lowest Bayesian information criterion (BIC) statistic was selected and used in subsequent analyses.

Table 1
Descriptive statistics for different operationalizations of signature size.

	N	Mean	St. Dev.	Min	Max
Bounding box	335	610.56	116.27	61.33	11230.54
Minimal rotated bounding box	335	538.26	100.62	49.86	11094.60
Convex hull	335	398.61	71.87	39.16	7334.11

Different operationalizations of signature size. Area values are back-transformed, and expressed in square millimeters. Bounding Box: Signature bounding box area; Minimal Rotated Bounding Box: Minimal rotated signature bounding box area; Convex Hull: Signature convex hull area.

In a second step, alternative models were generated by separately adding—to the null model—each predictor variable (personality traits). In another analysis (shown in [Supplementary Materials](#)) we included a single alternative model that included all predictor variables. The effect of the interaction between sex and personality traits was analyzed by constructing alternative models with two coefficients for the effect of personality traits in males and females respectively. For two predictor variables, the coefficients for females reached significance whereas the coefficients for males did not. The significance of this differences was assessed by constructing models with two coefficients: one for the effect of the personality trait on males, and one for the difference of the effect between males and females. Also, to assess the robustness of the results, some of the regression analyses described above were also performed without controlling for potential confounders in a null model (see [Supplementary Tables S5 and S6](#)).

For all models, significance of the predictor coefficients was assessed through *t*-tests on the standardized regression coefficients. Adjusted *p*-values were calculated using Benjamini-Hochberg corrections for false discovery rate. *F*-tests for improved model fit were also calculated when needed. Since heteroscedasticity in the data was present (for the signature size null model, studentized Breusch-Pagan BP = 16.175, $p = 0.023$), White-Huber corrections for covariance matrices were calculated and included in the analyses. All statistical analyses were performed using R statistics software ([R Core Team, 2015](#)).

3. Results

3.1. Correlations between different signature size measures

All three different operationalizations of signature size, i.e., signature bounding box area, minimal rotated signature bounding box area, and convex hull area were highly correlated, with Pearson correlation coefficients ranging from 0.978 to 0.990 (see [Table 2](#)).

3.2. Correlations between demographic variables, signature size, signature style, printed name metrics, and personality traits

Pearson correlation coefficients were calculated to test for significant linear associations of the different measures of signature size—i.e., signature bounding box area, minimal rotated bounding box area, and signature convex hull area—with signature style, sex, age, printed name area, number of characters in printed name, average character area (in printed name), and personality traits. Since this was an exploratory analysis, significance values were not corrected for multiple comparisons.

For the signature bounding box area, significant two-tailed positive correlations were found with sex ($r = 0.15$, $p < 0.01$), age ($r = 0.22$, $p < 0.001$), average character area (in printed name) ($r = 0.43$, $p < 0.001$), printed name area ($r = 0.45$, $p < 0.001$), but

not with number of characters in printed name ($r = 0.08$, $p = 0.14$). That is, signature size was larger for males, for older individuals, and for those individuals who used larger characters in their printed names, but signature size was not significantly associated with number or characters in printed name. Additionally, a significant correlation of the signature bounding box area with sociable dominance was observed ($r = 0.18$, $p < 0.01$). No significant correlations of signature bounding box area with intrasexual competition ($r = -0.01$, $p = 0.84$), aggressive dominance ($r = -0.01$, $p = 0.83$), self-esteem ($r = 0.00$, $p = 0.93$) or narcissism ($r = 0.04$, $p = 0.44$) were found. That is, individuals high in sociable dominance—but not those high in intrasexual competition, aggressive dominance, self-esteem or narcissism—exhibited larger signatures, as measured by the bounding box area (see [Table 4](#)).

Pearson correlation analyses of the two additional measures of signature size—i.e., minimal rotated bounding box area, and convex hull area—with signature style, sex, age, printed name area, number of characters in printed name, average character area (in printed name), and personality traits, resulted in virtually identical results to those obtained with the signature bounding box area (see [Supplementary Tables S1 and S2](#)).

3.3. Regression analyses on signature and printed name size

To assess the specific contribution of personality traits to signature size, two-step multiple hierarchical regression analyses were performed. The null model with the lowest BIC statistic for the signature size included the effects of age, average character area, number of characters in printed name and signature style, and the interactions of sex $\times$ age, signature style $\times$ number of characters and signature style $\times$ average character area.

Given that previous research ([Kettle & Häubl, 2011](#)) suggests that signatures—but not printed names—operate as representations of the self, we performed similar regression analyses on printed name size to explore whether the observed contribution of personality traits to handwritten productions were indeed restricted to signature production, or if they also affected printed name area.

The null model with the lowest BIC statistic for the printed name size included terms for sex, number of characters in printed name and their interaction.

3.3.1. Regression analyses on signature size

The null model for signature size showed significant contributions of age ($\beta = 0.31$, $p < 0.001$), signature style ($\beta = 0.70$, $p < 0.001$), number of characters in printed name ($\beta = -0.25$, $p = 0.025$), sex $\times$ age ($\beta = -0.25$, $p = 0.014$), signature style $\times$ number of characters in printed name ($\beta = 0.57$, $p < 0.001$), and signature style $\times$ average character area ($\beta = 0.51$, $p = 0.024$), while average character area alone failed to reach significance levels ($\beta = 0.28$, $p = 0.16$) (see [Table 5](#)). Overall, this null model was significant (adjusted $R = 0.57$; $F(7, 316) = 24.42$, $p < 0.001$). Hence, demographic variables and signature features have a substantial impact on signature size and should be considered when performing regression analyses on signature size in relation with psychological traits (see [Table 5](#)).

Alternative models did not reveal significant contributions of intrasexual competition, aggressive dominance, narcissism and self-esteem to signature size (β s between 0 and 0.04, *p*-values between 0.43 and 0.99). In contrast, a significant contribution of sociable dominance to signature size was observed ($\beta = 0.12$, $p = 0.021$). This contribution remained significant after correcting for false discovery rate (see [Table 5](#)). Given that the square root transformation is a monotonically increasing function, our results suggest that an increase in sociable dominance was associated with an increase in signature size measured as the signature

Table 2
Pearson correlations between different operationalizations of signature size.

	Bounding box	Minimal rotated bounding box	Convex hull
Bounding box	–		
Minimal rotated bounding box	0.99	–	
Convex hull	0.98	0.99	–

Bounding Box: Signature bounding box area; Minimal Rotated Bounding Box: Minimal rotated signature bounding box area; Convex Hull: Signature convex hull area.

Table 3

Descriptive statistics of personality trait measurements.

	N	Mean	St. Dev.	Min	Max	Cronbach's α
ISC	306	25.43	8.61	12.00	52.00	0.85
SD	319	28.30	5.57	13.00	40.00	0.75
AD	325	15.76	5.40	7.00	31.00	0.76
NPI	340	3.21	2.38	0.00	12.00	0.60
RSES	320	26.64	2.43	20.00	35.00	0.77

ISC: Intrasexual Competition; SD: Sociable Dominance; AD: Aggressive dominance; NPI: Narcissistic Personality Inventory; and RSES: Rosenberg's Self-Esteem Scale.

Table 4

Pearson correlation coefficients between demographic variables, signature bounding box area, signature style, printed name metrics, and personality traits.

	Sex	Age	Sign.Style	Sign.Area	#Characters	Char.Area	Name Area	ISC	SD	AD	NPI	RSES
Sex	–											
Age	0.10 (0.06)	–										
Sign.Style	–0.21 (<0.001***)	–0.15 (<0.01**)	–									
Sign.Area	0.15 (<0.01**)	0.22 (<0.001***)	0.22 (<0.001***)	–								
#Characters	–0.06 (0.30)	–0.08 (0.16)	–0.01 (0.85)	0.08 (0.14)	–							
Char.Area	0.23 (<0.001***)	0.11 (0.06)	–0.02 (0.66)	0.43 (<0.001***)	0.19 (<0.001***)	–						
Name Area	0.20 (<0.001***)	0.02 (0.65)	–0.04 (0.44)	0.45 (<0.001***)	0.41 (<0.001***)	0.74 (<0.001***)	–					
ISC	0.10 (0.08)	–0.16 (<0.01**)	0.10 (0.1)	–0.01 (0.84)	–0.05 (0.39)	0.05 (0.41)	0.00 (0.99)	–				
SD	0.07 (0.19)	0.19 (<0.001***)	–0.02 (0.69)	0.18 (<0.01**)	0.01 (0.84)	0.03 (0.60)	0.03 (0.63)	–0.14 (0.02*)	–			
AD	0.24 (<0.001***)	–0.16 (<0.01**)	0.09 (0.11)	–0.01 (0.83)	–0.04 (0.43)	0.09 (0.11)	0.05 (0.37)	0.44 (<0.001***)	0.01 (0.80)	–		
NPI	0.16 (<0.01**)	–0.07 (0.19)	0.06 (0.30)	0.04 (0.44)	–0.02 (0.69)	0.06 (0.32)	0.02 (0.74)	0.37 (<0.001***)	0.23 (<0.001***)	0.50 (<0.001***)	–	
RSES	0.13 (0.02*)	–0.03 (0.56)	–0.02 (0.70)	0.00 (0.93)	–0.03 (0.56)	0.03 (0.58)	–0.02 (0.70)	0.19 (<0.01**)	0.01 (0.84)	0.12 (0.05*)	0.09 (0.12)	–

Note: Sex was coded as: Female: 0, Male: 1. Signature style was coded as: Monogram or initials: 0, Expanded signature: 1.

Abbreviations: Sign.Style: Signature style. Sign.Area: Signature Area. Char.Area: average character area. #Characters: Number of character on printed name. ISC: intrasexual competition. SD: sociable dominance. AD: aggressive dominance. NPI: narcissism. RSES: self-esteem.

* $p < 0.05$.** $p < 0.01$.*** $p < 0.001$.

bounding box area. When all predictors are included in a single alternative model, no significant improvement of fit over the null model is observed ($F(5,248) = 0.70$, $p = 0.62$) (see [Supplementary Materials Table S7](#)). This may be due the inclusion of several factors which individually do not contribute to signature size—i.e., intrasexual competition, aggressive dominance, narcissism and self-esteem—, the fact that there is some degree of correlation between the personality traits (see [Table 4](#)), and to the decrease in the number of participants for whom all data is available. Identical regression analyses on alternative operationalizations of signature size were performed, yielding highly similar results (see [Supplementary Tables S3 and S4](#)). Similar results were also obtained when regressions were performed without null models—i.e., without controlling for potential confounding variables (see [Supplementary Table S5](#)).

3.3.2. Regression analyses on signature size, including sex interactions

Given that sex differences have been consistently reported in narcissism (e.g., [Grijalva et al., 2014](#)), and self-esteem (e.g., [Kling, Hyde, Showers, & Buswell, 1999](#)), and intrasexual competition (REF), and that sex differences have been observed in the relationship of signature features with dominance ([Jorgenson, 1977](#)) and narcissism ([Dillon, 1988](#)), we further explored the effect of interaction of sex and the personality traits included in this study. In these analyses, each alternative model included separate coefficients for the effect of individual personality traits for each sex (see [Table 6](#)). A significant effect of sociable dominance ($\beta = 0.15$, $p = 0.024$) was found for females, but not for males ($\beta = 0.07$, $p = 0.42$). The differ-

ence between these two effects, however, failed to reach significance ($\beta = 0.08$, $p = 0.44$). Hence, we cannot conclude that the effects of sociable dominance on signature size are significantly different for males and females. In a similar vein, a significant effect of narcissism ($\beta = 0.14$, $p = 0.047$) was found for females, but not for males ($\beta = -0.1$, $p = 0.15$). The difference between these effects was also significant ($\beta = 0.24$, $p = 0.016$); that is, the effects of narcissism on signature size are significantly different for males and females. All other interaction effects tested—intrasexual competition $\times$ sex, aggressive dominance $\times$ sex, and self-esteem $\times$ sex—failed to reach significance (β s between -0.06 and 0.07 , p -values between 0.10 and 0.60). The same pattern of results is obtained when the regressions are performed without null models (see [Supplementary Table S6](#)). However, previously described significant interactions failed to reach significance after correcting for false discovery rate (see [Table 6](#)).

3.3.3. Regression analyses on printed name size

The null model showed a significant contribution of sex ($\beta = -0.45$, $p < 0.001$), and number of characters in the printed name ($\beta = 0.56$, $p \leq 0.001$) to printed name size. However, their interaction failed to reach significance levels ($\beta = -0.24$, $p = 0.20$) (see [Table 7](#)). Overall, this null model was significant (adjusted $R = 0.48$; $F(3,326) = 15.47$, $p < 0.001$); therefore, demographic variables and printed name features also show a significant contribution to the area of the printed name.

Alternative models including personality traits did not reveal significant contributions of these factors to printed name size (β s

Table 5

Two-step hierarchical multiple regression for signature size measured as the signature bounding box area.

		β [95%CI]	t	p-value	Corrected p-value	Adj. R	N
Null model	Age	0.31 [0.14, 0.48]	3.59	<0.001***	<0.01***	0.57 ^a	324
	Char. Area	0.28 [-0.12, 0.69]	1.39	0.16	0.24		
	#Characters	-0.25 [-0.47, -0.03]	-2.25	0.025*	0.029*		
	Sign. Style-NI	0.70 [0.42, 0.98]	4.96	<0.001***	<0.001***		
	Sex-F $\times$ Age	-0.25 [-0.46, -0.05]	-2.47	0.014*	0.042*		
	Sign. Style-NI $\times$ #Characters	0.57 [0.33, 0.82]	4.57	<0.001***	<0.001***		
	Sign. Style-NI $\times$ Char. Area	0.51 [0.07, 0.95]	2.27	0.024*	0.043*		
Model 1a	ISC	0.00 [-0.1, 0.1]	0.07	0.94	0.99	0.58	292
Model 1b	SD	0.12 [0.02, 0.22]	2.32	0.021*	0.043*	0.58	304
Model 1c	AD	0.00 [-0.1, 0.1]	0.00	0.99	0.99	0.57	311
Model 1d	NPI	0.04 [-0.06, 0.13]	0.79	0.43	0.57	0.57	324
Model 1e	RSES	0.02 [-0.07, 0.11]	0.36	0.72	0.79	0.57	306

Abbreviations: Sign. Style-NI: Signature style "Not-initials"; Char. Area: average character area in printed name; #Characters: Number of character on printed name; ISC: intrasexual competition; SD: sociable dominance; AD: aggressive dominance; NPI: narcissism; and RSES: self-esteem.

^a Null model fit: $F(7,316) = 24.42$, $p < 0.001$.

* Significance level: $p < 0.05$.

** Significance level: $p < 0.01$.

*** Significance level: $p < 0.001$.

between -0.02 and 0.02 , p -values between 0.37 and 0.96) (see Table 7). Identical regression analyses on the two additional measures of printed name size—i.e., minimal rotated bounding box and convex hull area—were performed. These regression analyses showed no significant contribution of personality traits on either printed name size operationalization (data not shown).

4. Discussion

The scientific analysis of potential associations between handwritten production and personality traits, or behavior, requires the use of robust methods. Confirming our hypothesis, our results show that after controlling for different demographic variables, and signature and printed name features, signature size is positively related to sociable dominance, i.e., the higher the sociable dominance, the larger the signature area. Moreover, these results are not dependent on which of the three operationalizations of signature size is used (see Supplementary Tables S3 and S4).

According to Kalma et al. (1993) the main difference between sociable and aggressive dominance can be understood in terms of social orientation: while the former is characterized by a positive attitude towards others, a central position in groups, a strong need to dominate and a solid self-esteem, the latter is better described by a negative attitude towards other people, a peripheral position in groups, and a strong need to realize one's own goals even at the expense of personal relationships. Given the positive association of signature size and sociable dominance, larger signatures could be interpreted as a signal of the inclination to stand out and occupy a central position within a group. Intriguingly, aggressive domi-

nance—but not sociable dominance—has been found to be correlated with self-exhibition scores (Kalma et al., 1993).

Our results also suggest that high narcissism levels are related to an increase in signature size in females, while narcissism scores appear not to be significantly associated with signature size in males. While these results are in line with our second hypothesis—though only for women—, we cannot rule out the possibility that this interaction is due to sampling error since it failed to reach significance after controlling for false discovery rate. However, in line with our results, sex-differences in the association between narcissism and signature production were previously reported. Dillon (1988) observed that high narcissism levels were associated with the use of signature embellishments—exclamation marks or underlinings—in women, but not in men. That the association of signature area and narcissism may result from the inclusion of prominent flourishes—rather than text, or stylized text size—is an interesting possibility that will require further study. Such a mechanism would be consistent with the previously reported bias towards women in the use of jewelry—another form of adornment—and altering appearance in general (Buss, 1988), particularly in light of the proposed link between narcissism and mating strategies (Holtzman & Strube, 2011). Additionally, the fact that narcissism might be restricted to signature production only in women would be consistent with sex differences in the expression of narcissistic traits in everyday life. Buss and Chiodo (1991) observed that males tend to express narcissism through lack of empathy, while females are more likely to express narcissistic traits through extreme concern with physical appearance, of which handwritten signatures could be an expression. Similarly, it has been suggested

Table 6

Two-step hierarchical multiple regression for signature size measured as the signature bounding box area, discriminating for sex.

		β [95%CI]	t	p-value	Corrected p-value	Adj. R	Improved model fit F (p-value)	N
Null model	Age	0.3 [0.13, 0.47]	3.48	<0.001***	<0.01**	0.57 ^a	21.08 (<0.001***)	324
	Char. Area	0.26 [-0.14, 0.67]	1.27	0.21	0.33			
	#Characters	-0.24 [-0.46, -0.02]	-2.13	0.034*	0.08			
	Sign. Style-NI	0.74 [0.46, 1.02]	5.18	<0.001***	<0.001***			
	Sex-F	-0.15 [-0.35, 0.04]	-1.56	0.12	0.24			
	Sex-F $\times$ Age	-0.24 [-0.44, -0.04]	-2.37	0.018*	0.07			
	Sign. Style-NI $\times$ #Characters	0.56 [0.31, 0.8]	4.43	<0.001***	<0.001***			
	Sign. Style-NI $\times$ Char. Area	0.51 [0.06, 0.95]	2.25	0.025*	0.07			
Model 1a	Sex-M $\times$ ISC	-0.06 [-0.2, 0.08]	-0.86	0.39	0.49	0.59	0.51 (0.60)	292
	Sex-F $\times$ ISC	0.04 [-0.11, 0.18]	0.52	0.60	0.60			
Model 1b	Sex-M $\times$ SD	0.07 [-0.1, 0.23]	0.81	0.42	0.49	0.58	2.93 (0.05)	306
	Sex-F $\times$ SD ^b	0.15 [0.02, 0.28]	2.27	0.024*	0.074			
Model 1c	Sex-M $\times$ AD	-0.1 [-0.27, 0.07]	-1.14	0.25	0.38	0.57	0.95 (0.38)	311
	Sex-F $\times$ AD	0.05 [-0.07, 0.17]	0.78	0.44	0.49			
Model 1d	Sex-M $\times$ NPI	-0.1 [-0.24, 0.04]	-1.45	0.15	0.26	0.59	3.00 (0.05)	324
	Sex-F $\times$ NPI ^c	0.14 [0.01, 0.28]	1.99	0.047*	0.10			
Model 1e	Sex-M $\times$ RSES	0.06 [-0.08, 0.21]	0.88	0.38	0.49	0.57	0.56 (0.57)	306
	Sex-F $\times$ RSES	-0.04 [-0.16, 0.08]	-0.60	0.55	0.58			

Abbreviations: Sign.Style-NI: Signature style "Not-initials". Char. Area: average character area. #Characters: Number of character on printed name. ISC: intrasexual competition. SD: sociable dominance. AD: aggressive dominance. NPI: narcissism. RSES: self-esteem.

^a Null model fit: $F(8, 315) = 22.04$, $p < 0.001$ ***.

^b Regression coefficient for the difference between the effects for males and females: $\beta = 0.08$, $t = 0.77$, $p = 0.44$, corrected $p = 0.49$.

^c Regression coefficient for the difference between the effects for males and females: $\beta = 0.24$, $t = 2.42$, $p = 0.016$ *, corrected $p = 0.07$.

* Significance level: $p < 0.05$.

** Significance level: $p < 0.01$.

*** Significance level: $p < 0.001$.

that negative traits of narcissism—arrogance, egocentrism, hostility—are tolerated for male leaders, while deemed undesirable for female leaders; thus the sex bias in the association between signature size and narcissism might reflect a socially accepted channel for the expression of narcissistic traits in women.

In a previous study, Ham et al. (2013) reported a relatively strong association between signature size and narcissism. However, in this study using a larger sample ($N = 53$ vs $N = 324$) we found a much more moderate association between signature area and narcissism, and that this association would be restricted to females. While we cannot explain this difference, it would be worth exploring if these discrepancies could be due to signature size measure differences (e.g., signature area divided by number of characters in signature vs. signature area), controlling for potential confounding factors as predictors of signature size, or the fact that our sample consisted of psychology students. Additionally, the NPI scale used to assess narcissism showed a moderate reliability in our sample, which led to the exclusion of two items (see Section 2).

Since the population of Uruguay is predominantly of European descent (Hidalgo, Bengochea, Abilleira, Cabrera, & Alvarez, 2005; Sans, 2011), and is culturally close to Western societies, we do not believe that the discrepancies between our results and those reported in previous studies result from cultural differences. Furthermore, previous studies showed no differences in signature style between different Western cultures—Mohammed et al. (2008) found no differences in signature style between Hispanic and non-Hispanic populations in the United States.

While the effect size of sociable dominance, and the interaction between narcissism and sex, on signature size are moderate, the fact that similar results are obtained with different operationalizations of signature area makes the argument for a genuine relationship stronger, especially as we controlled for a variety of potentially confounding variables. Moreover, these effects are also significant when regressions are performed without considering these potentially confounding variables (see Supplementary Materials Tables S5 and S6).

Table 7

Two-step hierarchical multiple regression for the printed name size measured as the name bounding box area.

		β [95%CI]	t	p-value	Corrected p-value	Adj. R	N
Null model						0.48 ^a	330
	Sex-F	−0.45 [−0.68, −0.23]	−3.97	<0.001***	<0.001***		
	#Characters	0.56 [0.21, 0.9]	3.20	<0.01**	<0.01**		
	Sex-F × #Characters	−0.24 [−0.61, −0.13]	−1.29	0.20	0.52		
Model 1a	ISC	−0.01 [−0.11, 0.1]	−0.11	0.91	0.96	0.47	298
Model 1b	SD	0.00 [−0.1, 0.1]	−0.04	0.96	0.96	0.47	310
Model 1c	AD	0.02 [−0.07, 0.1]	0.42	0.67	0.96	0.47	315
Model 1d	NPI	−0.01 [−0.1, 0.09]	−0.16	0.87	0.96	0.47	330
Model 1e	RSES	−0.02 [−0.06, 0.02]	−0.89	0.37	0.75	0.47	310

Abbreviations: #Characters: Number of character on printed name. ISC: intrasexual competition. SD: sociable dominance. AD: aggressive dominance. NPI: narcissism. RSES: self-esteem.

^a Null model fit: $F(3, 326) = 15.468$, $p < 0.001$.

* Significance level: $p < 0.05$.

** Significance level: $p < 0.01$.

*** Significance level: $p < 0.001$.

In our study, neither sociable dominance nor narcissism appear to influence the size of printed names, suggesting that signatures, but not printed names reflect these personality traits. These results seem to be in line with previous evidence which suggests that signatures influence behavior by appealing to self-feelings, while printed names fail to do so (Kettle & Häubl, 2011). We believe this finding also adds to the evidence of a true association of signature size with sociable dominance and narcissism.

Our results do not support the existence of an association between self-esteem and signature size reported in previous research. It should be noticed that these previous studies used different correlates of self-esteem, e.g., professional status (Swanson & Price, 1972; Zweigenhaft, 1970, 1977), or satisfaction with academic performance (Zweigenhaft & Marlowe, 1973). When self-esteem scales were used, significant correlations were only found for one of the four scales analyzed (Mahoney, 1973, 1977). The contribution of dominance scores to the association between signature size and self-esteem was already recognized by Jorgenson (1977). Furthermore, it has been observed that the dominance loadings of self-esteem scales may influence the relationship between this attribute and other personality traits (e.g., Brown & Zeigler-Hill, 2004).

Our results show that signature size is strongly related to signature style. Since signing with one's initials, monogram, or just a paraph is not unusual, signing style should be considered in further studies regarding signature size in relation to personality traits. In this vein, Mohammed et al. (2008) observed a significant bias—towards women—in producing readable signatures. Thus, the approach followed in previous studies—i.e., the exclusive use of readable signatures—may fail to capture the actual influence of sex on handwritten signatures, and thus interfere with the characterization of an association of signatures and personality traits. In addition, some of these previous studies used small samples, or equated professional development psychological traits, i.e., self-esteem or social status (Ham et al., 2013; Swanson & Price, 1972; Zweigenhaft, 1970, 1977; Zweigenhaft & Marlowe, 1973).

In addition to the association between personality traits—i.e., personality characteristics that are stable over time—, a few studies have explored the effect of transient psychological states on signature size. Zweigenhaft and Marlowe (1973) observed an increase in signature size in a group of participants who were led to believe they had performed well in an intelligence task, and thus experienced an increase in self-esteem. According to Zweigenhaft, Blas and De Veas obtained similar results in an unpublished study (cited in Zweigenhaft, 1977). In the same vein, Rawal et al. (2014) observed that implicit affective cues modulate signature size. These findings provide an exciting avenue for further research.

Although we put great care in the preparation and conduction of this research, we are aware of its potential limitations and shortcomings. For the present study, we did not use a previously validated—and psychometrically robust—Spanish version of the NPI-16 scale. While we believe that the scale version used in the current research reached a reasonable reliability level after deleting two items, the moderate reliability of this scale could have affected our results; an instrument with a better reliability would have been preferable. Additionally, since our sample consisted exclusively of psychology students, our results might differ from previously reported data. Previous research was conducted with samples consisting of graduate business students (e.g., Ham et al., 2013) which we would expect to exhibit higher narcissism levels than psychology students.

In the present study we unambiguously demonstrate a link between personality traits and signature size, and also, in so doing, we offer a robust methodological approach to study the relationship between handwritten gestures and psychological traits that could be of value for further research.

Appendix A. Supplementary material

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.jrp.2016.09.004>.

References

- Allport, G. W., Vernon, P. E., & Powers, E. (1933). *Studies in expressive movement*. New York: Macmillan.
- Ames, D. R., Rose, P., & Anderson, C. P. (2006). The NPI-16 as a short measure of narcissism. *Journal of Research in Personality*, 40(4), 440–450. <http://dx.doi.org/10.1016/j.jrp.2005.03.002>.
- Atienza, F. L., Moreno, Y., & Balaguer, I. (2000). Análisis de la dimensionalidad de la Escala de Autoestima de Rosenberg en una muestra de adolescentes valencianos. *Revista de Psicología Universitas Tarraconensis*, 22(1–2), 29–42.
- Brown, R. P., & Zeigler-Hill, V. (2004). Narcissism and the non-equivalence of self-esteem measures: A matter of dominance? *Journal of Research in Personality*, 38(6), 585–592. <http://dx.doi.org/10.1016/j.jrp.2003.11.002>.
- Buss, D. M. (1988). The evolution of human intrasexual competition: Tactics of mate attraction. *Journal of Personality and Social Psychology*, 54(4), 616–628. <http://dx.doi.org/10.1146/annurev.an.14.100185.002241>.
- Buss, D. M., & Chiodo, L. M. (1991). Narcissistic acts in everyday life. *Journal of Personality*, 59(2), 179–215. <http://dx.doi.org/10.1111/j.1467-6494.1991.tb00773.x>.
- Buunk, A. P., & Fisher, M. (2009). Individual differences in intrasexual competition. *Journal of Evolutionary Psychology*, 7(1), 37–48. <http://dx.doi.org/10.1556/JEP.7.2009.1.5>.
- Buunk, A. P., Zurriaga, R., González, P., & Castro-Solano, A. (2012). Competición intrasexual en el trabajo: Diferencias sexuales en celos y envidia en el trabajo. *Revista de Psicología Social*, 27(1), 85–96. <http://dx.doi.org/10.1174/021347412798844015>.
- Chou, E. Y. (2015). What's in a name? The toll e-signatures take on individual honesty. *Journal of Experimental Social Psychology*, 61, 84–95. <http://dx.doi.org/10.1016/j.jesp.2015.07.010>.
- Dillon, K. M. (1988). Narcissism and embellishments of signature. *Psychological Reports*, 62(1), 152–154.
- Eisenberg, P., & Reichline, P. B. (1939). Judging expressive movement: II. Judgements of dominance-feeling from motion pictures of gait. *The Journal of Social Psychology*, 10, 345–357.
- Fisher, M., & Cox, A. (2011). Four strategies used during intrasexual competition for mates. *Personal Relationships*, 18(1), 20–38. <http://dx.doi.org/10.1111/j.1475-6811.2010.01307.x>.
- Furnham, A., & Gunter, B. (1987). Graphology and personality: Another failure to validate graphological analysis. *Personality and Individual Differences*, 8(3), 433–435. [http://dx.doi.org/10.1016/0191-8869\(87\)90045-6](http://dx.doi.org/10.1016/0191-8869(87)90045-6).
- García Garduño, J. M., & Cortés Sotres, J. F. (1998). La Medición Empírica del Narcisismo. *Psicothema*, 10, 725–735.
- Goncalves, M. K., & Campbell, L. (2014). The Dark Triad and the derogation of mating competitors. *Personality and Individual Differences*, 67, 42–46. <http://dx.doi.org/10.1016/j.paid.2014.02.003>.
- Grijalva, E., Newman, D. A., Tay, L., Donnellan, M. B., Harms, P. D., Robins, R. W., & Yan, T. (2014). Gender differences in narcissism: A meta-analytic review. *Psychological Bulletin*, 141(2), 261–310.
- Grijalva, E., & Zhang, L. (2015). Narcissism and self-insight: A review and meta-analysis of narcissists' self-enhancement tendencies. *Personality and Social Psychology Bulletin*, 41(1), 3–24. <http://dx.doi.org/10.1177/0146167215611636>.
- Ham, C., Seybert, N., & Wang, S. (2013). *Narcissism is a bad sign: CEO signature size, investment, and performance* (UNC-Kennan Flager Business School Working Papers No. 2013–1). UNC-Kennan Flager Business School White Papers.
- Hidalgo, P. C., Bengochea, M., Abilleira, D., Cabrera, A., & Alvarez, I. (2005). Genetic admixture estimate in the Uruguayan population based on the loci LDLR, GYPA, HBGG, GC and D7S8. *International Journal of Human Genetics*, 5(3), 217–222.
- Hoaglin, D. C., & Iglewicz, B. (1987). Fine-tuning some resistant rules for outlier labeling. *Journal of the American Statistical Association*, 82, 1147–1149.
- Holtzman, N. S., & Strube, M. J. (2011). The intertwined evolution of narcissism and short-term mating: An emerging hypothesis. In W. K. Campbell & J. D. Miller (Eds.), *The handbook of narcissism and narcissistic personality disorder: Theoretical approaches, empirical findings, and treatments* (pp. 210–220). John Wiley & Sons, Inc.
- Hull, C. L., & Montgomery, R. B. (1919). An experimental investigation of certain alleged relations between character and hand writing. *Psychological Review*, 26(1), 63–74. <http://dx.doi.org/10.1037/h0073744>.
- Jorgenson, D. O. (1977). Signature size and dominance: A brief note. *Journal of Psychology*, 97(2), 269–270.
- Kalma, A. P., Visser, L., & Peeters, A. (1993). Sociable and aggressive dominance: Personality differences in leadership style? *The Leadership Quarterly*, 4(1), 45–64.
- Kettle, K. L., & Häubl, G. (2011). The signature effect: Signing influences consumption-related behavior by priming self-identity. *Journal of Consumer Research*, 38, 474–489.
- King, R. N., & Koehler, D. J. (2000). Illusory correlations in graphological inference. *Journal of Experimental Psychology: Applied*, 6(4), 336–348. <http://dx.doi.org/10.1037/1076-898X.6.4.336>.
- Klimoski, R. J., & Rafaeli, A. (1983). Inferring personal qualities through handwriting analysis. *Journal of Occupational Psychology*, 56(3), 191–202. <http://dx.doi.org/10.1111/j.2044-8325.1983.tb00127.x>.
- Kling, K. C., Hyde, J. S., Showers, C. J., & Buswell, B. N. (1999). Gender differences in self-esteem: A meta-analysis. *Psychological Bulletin*, 125(4), 470–500. <http://dx.doi.org/10.1037/0033-2909.132.1.33>.
- Mahoney, E. R. (1973). Signature size and self-estimation: A brief note. *Journal of Psychology*, 84(2), 223–224.
- Mailhos, A., Buunk, A. P., & del Arca, D. (2013). La relación 2D:4D muestra una leve correlación positiva con la dominancia agresiva, pero no con la dominancia social, en jugadores de fútbol de categorías formativas de un equipo de Primera División en Uruguay. *Ciencias Psicológicas*, 7(2), 143–150.
- Mohammed, L., Found, B., & Rogers, D. (2008). Frequency of signature styles in San Diego county. *Journal of the American Society of Questioned Document Examiners*, 11(1), 9–14.
- Neter, E., & Ben-Shakhar, G. (1989). The predictive validity of graphological inferences: A meta-analytic approach. *Personality and Individual Differences*, 10(7), 737–745. [http://dx.doi.org/10.1016/0191-8869\(89\)90120-7](http://dx.doi.org/10.1016/0191-8869(89)90120-7).
- R Core Team (2015). *R: A language and environment for statistical computing*. Vienna, Austria: R Foundation for Statistical Computing. Retrieved from <<http://www.r-project.org/>>.
- Rawal, A., Harmer, C. J., Park, R. J., O'Sullivan, U. D., & Williams, J. M. G. (2014). A sense of embodiment is reflected in people's signature size. *PLoS ONE*, 9(2), e88438. <http://dx.doi.org/10.1371/journal.pone.0088438>.
- Rosenberg, M. (1965). *Society and the adolescent self-image*. Princeton, NJ: Princeton University Press.
- Sans, M. (2011). National identity, census data, and genetics in Uruguay. In S. Gibbon, R. Ventura Santos, & M. Sans (Eds.), *Racial identities, genetic ancestries, and health in South America* (Vol. 1, pp. 195–212). New York, NY: Palgrave Macmillan.
- Shu, L. L., Mazar, N., Gino, F., Ariely, D., & Bazerman, M. H. (2012). Signing at the beginning makes ethics salient and decreases dishonest self-reports in comparison to signing at the end. *Proceedings of the National Academy of Sciences*, 109(38), 15197–15200. <http://dx.doi.org/10.1073/pnas.1209746109>.
- South, S. C., Oltmanns, T. F., & Turkheimer, E. (2003). Personality and the derogation of others: Descriptions based on self- and peer report. *Journal of Research in Personality*, 37(1), 16–33. [http://dx.doi.org/10.1016/S0092-6566\(02\)00526-3](http://dx.doi.org/10.1016/S0092-6566(02)00526-3).
- Swanson, B. R., & Price, R. L. (1972). Signature size and status. *The Journal of Social Psychology*, 87(2), 319.
- Wallace, H. M. (2011). Narcissistic self-enhancement. In *The handbook of narcissism and narcissistic personality disorder: Theoretical approaches, empirical findings, and treatments* (pp. 309–318).
- Zweigenhaft, R. L. (1970). Signature size: A key to status awareness. *The Journal of Social Psychology*, 81(1), 49–54.
- Zweigenhaft, R. L. (1977). The empirical study of signature size. *Social Behavior and Personality*, 5(1), 177–185.
- Zweigenhaft, R. L., & Marlowe, D. (1973). Signature size: Studies in expressive movement. *Journal of Consulting and Clinical Psychology*, 40(3), 469–473.