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# The genetic and psychological underpinnings of generalized social trust

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## ABSTRACT

In this paper, we investigate the genetic and psychological underpinnings of generalized social trust, an orientation that refers to one's expectations about the trustworthiness of strangers. We make a number of contributions to the literature. First, using a new dataset containing information on a large sample of German twin pairs ( $N=1980$  pairs), we replicate previous studies on the heritability of social trust. Our analysis supports previous research showing modest heritability estimates for social trust. Second, we examine whether seven different psychological traits (openness, conscientiousness, extraversion, agreeableness, neuroticism, self-efficacy, and cognitive ability) are related to social trust, a number of which we find are correlated with trust in theoretically expected ways. Lastly, we estimate the extent to which genetic factors account for the correlation between psychological traits and social trust. We find evidence that genetic factors account for a large amount of the correlation between social trust and two psychological traits—agreeableness and neuroticism. In addition, we find that the correlation between cognitive ability and social trust is primarily due to common environment. Our results provide important insights on the underpinnings of social trust.

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## Introduction

Generalized social trust, or 'the belief that most people can be trusted,' has been the subject of a considerable amount of research over the last several decades (Uslaner, 2012, p. 6). It is not surprising that this concept has attracted so much attention given that social trust 'has been suggested as the root cause of much of what is valued in today's societies' (Oskarsson, Dawes, Johannesson, & Magnusson, 2012, p. 21).<sup>1</sup> Numerous studies have found evidence that high levels of social trust have wide-ranging, positive effects on society and individuals (Dinesen & Bekkers, 2017; Nannestad, 2008; Putnam, 1993; Sullivan & Transue, 1999; Uslaner, 2002). Some of the most important research on the effects of social trust has established a link between generalized social trust and collective action (Putnam, 1993; Sønderskov, 2009, 2011). Sønderskov (2011) notes, for

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example, that 'Generalized social trust enhances large-N cooperation because most humans tend to cooperate when they expect others to do the same' (p. 66). The concept of social trust is so important that research on its causes and consequences spans multiple disciplines, including political science, psychology, economics, and sociology.

Although research on the effects of generalized social trust is critically important, in this paper we are interested in understanding the *underpinnings* of social trust. To date, there has been a large body of research on the role of contextual factors in shaping social trust, and we now know a fair amount about the contextual determinants (e.g. levels of income inequality, corruption, ethnic diversity, experiences in social networks, institutional quality, etc.) of social trust (for excellent overviews of existing research, see the following studies: Delhey & Newton, 2003; Dinesen & Bekkers, 2017; Nannestad 2008). Dinesen and Bekkers (2017) note that this type of research represents the *experiential perspective*, which 'considers trust to be malleable through experiences. More specifically, individuals are expected to continuously update their trust in others based on their experiences - good or bad - throughout life' (p. 79). In this paper, we are interested in the psychological and biological underpinnings of generalized social trust. Such research typically falls within the *dispositional perspective* (Dinesen & Bekkers, 2017). Accordingly, 'trust is considered a deep-seated disposition or belief that varies between individuals. After the formative years, the rank order of individuals from low to high trust changes little. In parts of the literature, trust is considered a downstream consequence of proximate dispositions such as personality traits' (Dinesen & Bekkers, 2017, p. 79). Although some studies have examined the link between psychological traits and social trust, relatively little research has explored the link between biological factors and social trust (but see Hiraishi, Yamagata, Shikishima, & Ando, 2008; Merolla, Burnett, Pyle, Ahmadi, & Zak, 2013; Oskarsson et al., 2012; Sturgis, Read, Hatemi, et al., 2010). Even less research has considered the link between biology, psychological traits, and generalized trust (but see Hiraishi et al., 2008; Oskarsson et al., 2012). In a recent article, Merolla et al. (2013) note that it is 'possible that variation in trust across individuals is *even more basic and more fluid* than it is typically presented in political behavior research. The literature is just beginning to explore the relationship of biology to trust' (p. 756, *italics added for emphasis*). Preliminary evidence on the link between biological factors and social trust, such as Merolla et al.'s (2013) finding that oxytocin increases individuals' interpersonal trust and Sturgis, Read, and Allum's (2010) finding that social trust is heritable, indicates that additional research in this area is justified. While our focus here is on dispositional trust, we should make it clear at the outset that the experiential and dispositional perspectives are not incompatible. As Dinesen and Bekkers (2017) point out, 'experiences in childhood may influence trust (or antecedent dispositions), which is then subsequently stable over the adult life course. Similarly, they may also interact. Dispositions such as personality traits may for example influence how certain experiences are perceived and influence trust' (pp. 79–80).

In this article, we examine two questions about generalized social trust. First, we are interested in the origins of social trust. To study this question, we use a technique that allows us to estimate the extent to which this orientation is heritable and the extent to which it is driven by environmental factors. Second, given previous research on the link between many psychological traits and social trust (and strong theoretical expectations about how each trait will be related to generalized trust), the heritability of psychological

traits, and the heritability of social trust, we are interested in determining whether there is genetic overlap between psychological traits and social trust. We make a number of contributions to the literature. One of our key contributions is to provide a more comprehensive look at the psychological traits that are related to social trust than previous studies. In doing this, we are able to synthesize research on the genetic basis of social trust and research on the relationship between psychological traits and social trust. Only a few studies have tried to examine the genetic overlap between psychological traits and social trust (Hiraishi et al., 2008; Oskarsson et al., 2012), so we are able to advance the limited body of literature in this area by considering genetic and psychological traits simultaneously. Our study is different from work by Hiraishi et al. (2008) and Oskarsson et al. (2012) because we are able to integrate measures from the Big Five personality model, which has become the key personality model in psychology (John & Srivastava, 1999), and psychological measures that are not included in the Big Five model but that are likely important to social trust. Hiraishi et al. (2008) had measures of the Big Five traits, but no other psychological traits, and Oskarsson et al. (2012) had a measure of just one of the Big Five traits (extraversion) and two traits that fall outside of the Big Five model (personal control and cognitive ability).<sup>2</sup> We have measures of seven different psychological traits (openness, conscientiousness, extraversion, agreeableness, neuroticism, self-efficacy, and cognitive ability). In addition to developing the limited body of research on the genetic and psychological underpinnings of trust, we are able to make use of a new dataset that contains information on a large sample of German twin pairs ( $N = 1980$  pairs). Because we have data on twins and numerous psychological measures, we are able to estimate the extent to which genetic factors account for the correlation between psychological traits and social trust in a new context. The study by Hiraishi et al. (2008) used data from a Japanese sample and the study by Oskarsson et al. (2012) used data from Sweden. It is critical to examine hypotheses in a range of different samples and contexts.

The rest of this article proceeds in a straightforward manner. In the next section, we provide an overview of the literature on the psychological and biological underpinnings of social trust. We then proceed to a discussion about the possible connection between genes, psychological traits, and social trust. After describing our data and measures, we analyze the link between genes, seven psychological traits, and social trust. We conclude with a discussion of the implications of our results and ideas for future research.

### ***The psychological and biological underpinnings of social trust***

Although researchers across a variety of disciplines have been interested in the determinants of social trust for some time now, we focus our attention on the relatively new body of literature on the psychological and biological etiology of social trust. Freitag and Bauer have pointed out that 'The bulk of the research on the foundations of social trust ... mainly concentrates on evaluations of *one's social environment*, while empirical evidence on the *psychological origins of social trust is quite rare*' (2016, p. 467, *italics added for emphasis*). Indeed, to date only a handful of studies have examined the impact of psychological traits on social trust. We begin by describing these studies and then move to a discussion of research on the heritability of generalized trust.

Thus far, much of the research on the psychological basis of trust has focused on the Big Five personality traits, which are openness, conscientiousness, extraversion, agreeableness, and neuroticism (see Anderson, 2010; Dinesen, Nørgaard, & Klemmensen, 2014; Dohmen, Falk, Huffman, & Sunde, 2008; Freitag & Bauer, 2016; Hiraishi et al., 2008; Mondak & Halperin, 2008; Mondak, Hayes, & Canache, 2017; Oskarsson et al., 2012). In order to summarize the results of these studies in an efficient manner, Table 1 shows the relationship between each personality trait and generalized trust for each study. Overall, the most consistent finding has been the positive association between agreeableness and trust. Openness and extraversion are positively correlated with trust in four of the eight studies in Table 1. Across studies, neuroticism has been negatively associated with trust, although three of the eight studies in Table 1 found that is not significantly correlated with trust. Finally, there are some mixed findings regarding conscientiousness; three studies found negative correlations between this trait and trust and one study reported a positive correlation, with the remaining studies finding no statistically significant relationship.

A few studies have examined the link between psychological and personality traits that are not included in the Big Five model and social trust. For example, in his seminal work on social trust, Uslander (2002) finds that optimism and a sense of control (the belief that one can control one's own life) are among the most important predictors of generalized social trust. In addition, Oskarsson et al. (2012) find that personal control is positively correlated with social trust. They also demonstrate that intelligence is positively related to social trust, though they only have a measure of intelligence among men in their sample. In a similar vein, Hooghe, Marien, and De Vroome (2012) find a substantial association between cognitive ability and social trust. Sturgis, Read, and Allum (2010) also report that intelligence is an important predictor of social trust. More specifically, they show that measures of intelligence collected at an early age explain variability in measures of trust collected in early middle age. Carl and Billari (2014) examine the impact of intelligence on generalized social trust using cross-sectional data and find that intelligence has a strong, positive effect on trust.

A number of studies have investigated the extent to which generalized social trust is heritable. In most studies, heritability estimates are in the range of 30–40%. For example, Hiraishi et al. (2008) report a heritability estimate of 31% for generalized trust in a Japanese sample. Oskarsson et al. (2012) find a heritability estimate of 36% (33% for males and 39% for females) in a Swedish sample. In a different analysis of Swedish twins, Oskarsson, Dinesen, Dawes, Johannesson, and Magnusson (2017) report a

**Table 1.** Summary of existing studies on big five traits and generalized trust.

Study	Sample	O	C	E	A	N
Mondak and Halperin 2008	U.S	ns	ns	ns	+	ns
Dohmen et al. 2008	Germany	+	–	ns	+	–
Hiraishi et al. 2008	Japan	+	+	+	+	–
Anderson 2010	U.S.	ns	ns	ns	+	ns
Oskarsson et al. 2012	Sweden	n/a	n/a	+	n/a	n/a
Dinesen, Nørgaard and Klemmensen 2014	Denmark	+	–	+	+	–
Freitag and Bauer 2016	Switzerland	+	–	ns	+	ns
Mondak, Hayes and Canache 2017	24 countries	ns	ns	+	+	–

Notes: ns, not significant; +, positive; –, negative; n/a, not applicable (since trait was not measured).

heritability estimate of 37%. Using data from Australian samples, Sturgis, Read, Hatemi, et al. (2010) find heritability estimates between 14% to 36% (all of which are statistically significant at the 5% level) for the four survey items in their study that measure trust, and 66% for a latent trust factor that combines the four items. Using data from the United Kingdom, Wootton, Davis, Mottershaw, Wang, and Haworth (2016) report that the heritability of generalized trust is 35%. In addition, using measures of trust collected from a trust game, Cesarini et al. (2008) report heritability estimates of 20% in a Swedish sample and 10% in a U.S. sample. In a recent study, Reimann, Schilke, and Cook (2017) find that trust has a significant genetic component (30% heritable), but that distrust, which they argue is not simply the opposite of trust, does not. Instead, distrust appears to be primarily driven by socialization, including familial influences. Interestingly, Van Lange, Vinkhuyzen, and Posthuma (2014) report a fairly low heritability estimate (5%, *ns*) using data from the Netherlands. Although they recognize that trust is heritable in some contexts, they note that ‘genetic influences are modest at most’ (p. 7).

A recent line of research has attempted to understand the link between genetic factors, psychological traits, many of which are heritable, and social trust. In short, studies in this area aim to understand the degree to which social trust and psychological traits share the same genetic etiology. For example, Hiraishi et al. (2008) find that general trust is estimated to be 9% and 6% reactively heritable through extraversion and agreeableness, respectively. In addition, Oskarsson et al. (2012) find that social trust is phenotypically related to extraversion, personal control, and intelligence, all three of which are heritable, and that genetic factors account for most of these correlations. They conclude that ‘the relationships between social trust and the three psychological traits are largely driven by common genetic sources’ (p. 27).

In this article, we build on previous research by investigating the link between genes, seven psychological traits (openness, conscientiousness, extraversion, agreeableness, neuroticism, self-efficacy, and cognitive ability), and generalized trust. Although a number of these traits have been examined in previous studies, we are interested in extending existing work by considering a broader array of personality and psychological traits. In addition, although several studies on the etiology of social trust have been conducted using non-US samples, we are not aware of any studies on the link between genes, psychological traits, and social trust that have made use of German samples. In this paper, we use a newly-released, genetically informative dataset on same-sex German twin pairs reared together. Thus, our study allows us to examine our hypotheses in a new context. When possible, research findings should be examined using multiple datasets, across different contexts, and in different time periods.

### ***Linking genes, psychological traits, and social trust***

Given the research outlined above, we believe it is important and worthwhile to expand the study of individual differences and orientations like social trust. In this article, we are interested in the connection between genes, the Big Five personality traits, self-efficacy, cognitive ability, and social trust. As we noted above, several previous studies (Hiraishi et al., 2008; Oskarsson et al., 2012, 2017; Sturgis, Read, Hatemi, et al., 2010; Wootton et al., 2016) have illustrated that generalized trust is moderately heritable. However, existing studies are only just starting to provide insight into the connections between

biological factors, psychological traits, and social trust. In a recent literature review on social trust, Dinesen and Bekkers (2017) note that an important topic for future research on social trust is to examine whether 'the relationship between the two [personality traits and social trust] is explained by common genetic and/or environmental factors' (p. 83). Below, we provide an overview of our expectations, guided by previous research, about how psychological traits might be related to generalized trust. We note that although a few previous studies have found that only some Big Five traits are related to social trust, existing literature provides clear hypotheses about how each trait might influence generalized trust. In addition, in some studies (e.g. Dinesen et al., 2014; Hiraishi et al., 2008), all five traits have been statistically significant predictors of social trust. Thus, we believe it is reasonable to examine all five traits in this study. We begin by discussing the Big Five traits and then move to a discussion of self-efficacy and cognitive ability.

As a brief overview, the Big Five are among the most widely researched personality traits within the field of psychology and, as John and Srivastava (1999) note, 'After decades of research, the field is approaching consensus on a general taxonomy of personality traits, the "Big Five" personality dimensions.' In brief, 'The Big-Five framework suggests that most individual differences in human personality can be classified into five broad, empirically derived domains' (Gosling, Rentfrow, & Swann, 2003, p. 506). Numerous studies have confirmed that the Big Five traits are heritable (Bouchard, 1994, 2004; Jang, Livesley, & Vernon, 1996; Loehlin, McCrae, Costa, & John, 1998; McCrae & Costa, 2003; Stelmack, 1991). Previous research provides hypotheses about how each of the Big Five traits might influence social trust.

The first trait we consider is openness. In general, people with high scores on openness tend to be imaginative, curious, and open to new ideas and experiences. Past research has noted that those with high scores on openness 'may be expected to trust other people more due to their tolerant and open-minded nature' (Dinesen et al., 2014, p. 4). Thus, following previous research (Dinesen et al., 2014; Freitag & Bauer, 2016; Hiraishi et al., 2008), we expect openness to have a positive effect on social trust.

The next trait we consider is conscientiousness. Typically, those with high scores on this trait are thorough, organized, and think before acting. Freitag and Bauer (2016) have pointed out that 'Conscientious persons make decisions very carefully and seek to retain control over a situation (trust, but verify). Being cautious, conscientious persons do not easily trust the information they get from others or other people's actions and decisions' (p. 470). A number of other scholars have echoed this idea (Dinesen et al., 2014). This leads to the expectation that conscientiousness will be negatively related to social trust.

We also consider the link between extraversion and social trust. Extraverted people tend to be outgoing, assertive, and sociable. Oskarsson et al. (2012) argue that 'extraversion, which is marked by sociability and an eagerness to engage with others and construct new social relationships, should increase the opportunities an individual has to benefit from higher social trust' (p. 22). Freitag and Bauer (2016), Dinesen et al. (2014), and Hiraishi et al. (2008) also suggest that extraversion should be positively related to social trust. For example, Hiraishi point out that 'The advantages of high general trust flow from newly created beneficial social relationships. If an individual has an introverted personality and likes to be alone, that person will have difficulty constructing new social relationships and will fail to benefit from higher general trust' (p. 81).



Agreeableness should also be related to social trust. Freitag and Bauer note that 'Agreeable persons are cooperative, warm, kind, and avoid conflicts. Persons with high agreeableness show a caring and kind orientation toward other people. They are interested in having good relationships with their fellow citizens and are characterized by a communal orientation. In general, agreeableness should be accompanied by high levels of trust in other people, since agreeable persons simply tend to "believe the best of others" (McCrae & Costa, 2003, p. 50)' (p. 469). A positive relationship between agreeableness and general trust has been suggested by numerous other scholars (Dinesen et al., 2014; Hiraishi et al., 2008; Mondak & Halperin, 2008). One important thing to note about agreeableness is that one of the facets of this trait is trust. Thus, measures of agreeableness sometimes include items that mention trust.<sup>3</sup> In order to avoid circularity problems, researchers who have examined the impact of agreeableness on generalized trust have typically removed any items that could possibly capture trust from their measure of agreeableness.<sup>4</sup> For example, this approach is followed by Dinesen et al. (2014), Freitag and Bauer (2016), and Hiraishi et al. (2008).<sup>5</sup> Importantly, in all analyses (Dinesen et al., 2014; Freitag & Bauer, 2016; Hiraishi et al., 2008) that have used "reduced" measures of agreeableness, there have still been statistically significant relationships between agreeableness and generalized trust.

The final Big Five trait is neuroticism. People with high scores on this trait tend to be nervous, high-strung, anxious, and prone to worrying. Freitag and Bauer (2016) argue that since

neurotic individuals tend to worry more, they should display lower levels of trust. When such individuals judge the trustworthiness of others it is more likely that they envision negative scenarios. People who score high on neuroticism are more likely to perceive a potential betrayal by the trustee and, consequently, are less likely to trust him or her. (p. 469)

A similar hypothesis is proposed by Dinesen et al. (2014).<sup>6</sup> Thus, we expect a negative relationship between neuroticism and social trust.

In addition to the Big Five traits, we consider self-efficacy and cognitive ability. Although the Big Five model provides an important framework for thinking about and measuring personality traits, it is important to note that 'there are plenty of dimensions ... beyond the Big Five' (Paunonen & Jackson, 2000, p. 821). Thus, we are interested in exploring whether traits that are not measured in the Big Five model are related to social trust in theoretically expected ways. Once again, existing literature provides ideas about how self-efficacy and cognitive ability might influence general trust. Although self-efficacy and personal control are not exactly the same, they are strongly related (Judge, Erez, Bono, & Thoresen, 2002). Self-efficacy typically refers to confidence in one's ability to control one's own motivation, behavior, and environment. A number of analyses have found evidence that self-efficacy is moderately heritable (Dawes et al., 2014; Weinschenk, Dawes, Kandler, Bell, & Riemann, 2017). Previous work on personal control provides reason to believe that self-efficacy should be positively related to social trust. For example, Oskarsson et al. (2012) note that 'Individuals who believe they are the masters of their own fate should be more willing to trust strangers in order to reap the benefits of outside opportunities' (p. 22). Cognitive ability should also be positively related to generalized trust. Typically, measures of cognitive ability or intelligence are used as a way of getting at social intelligence, which should be important to trust. As Hooghe et al. (2012) point out



If trust depends on an assessment of how others will deal with the interests of the actor, intelligence allows actors to determine more successfully the motivations of other actors one encounters and interacts with ... Intelligence can be seen as an important resource in the effort to make sense of the signals that are being sent out with regard to potential defection or untrustworthy behavior. (p. 604)

Numerous other studies have articulated similar hypotheses about the connection between cognitive ability and generalized social trust (Carl & Billari, 2014; Oskarsson et al., 2012; Sturgis, Read, and Allum, 2010). We should note that researchers have consistently found that cognitive ability is heritable (Dawes et al., 2014; Haworth et al., 2009; Oskarsson et al., 2015, 2012; Weinschenk et al., 2017).

### Data and measures

Our data come from the TwinLife Study, which is a genetically informative, longitudinal study of same-sex German twin pairs reared together.<sup>7</sup> Data collection for the study began in 2014 and will continue for nine years. The study employs a cross-sequential design wherein people of different age groups are examined multiple times. The TwinLife study is based on four cohorts of identical and fraternal twins (twins born between 1990–1993, twins born in 1997/1998, twins born in 2003/2004, and twins born in 2009/2010). Since September 2017, data collected from the first face-to-face survey of the whole sample (4097 twin pairs and their families) has been made available to researchers.

The first survey included in the TwinLife Study contains items measuring generalized social trust, the Big Five personality traits, self-efficacy, and cognitive ability. Full question wordings are provided in the *Online Appendix*. To measure social trust, we use two items (*On the whole one can trust people* and *Nowadays one can't rely on anyone*—reverse coded, Pearson's  $r = 0.47$ ,  $p < 0.001$ ,  $\alpha = 0.64$ ). Given the young age of some of the twins in the study, some questions were not asked of every cohort.<sup>8</sup> In total, there are 3960 respondents (1982 monozygotic (MZ) twins and 1978 dizygotic (DZ) twins), which amounts to 1980 twin pairs, with non-missing responses on the psychological and social trust measures we analyze in this paper.

To measure the Big Five personality traits, respondents in the TwinLife Study were asked to report how well a variety of different sentences describe them (e.g. *I see myself as someone who is outgoing, sociable*). Full question wordings are provided in the *Online Appendix*.<sup>9</sup> We created overall measures of personality for each of the Big Five personality traits by combining relevant items (all of the Big Five measures are based on between 3 and 7 survey items). Reliability scores are as follows:  $\alpha = 0.79$  (extraversion),  $\alpha = 0.70$  (conscientiousness),  $\alpha = 0.62$  (openness),  $\alpha = 0.75$  (neuroticism), and  $\alpha = 0.55$  (agreeableness).<sup>10</sup> To measure self-efficacy, we use three survey questions (*I can rely on my own abilities in difficult situations; I am able to solve most problems on my own; I can usually solve even challenging and complex tasks well*,  $\alpha = 0.75$ ). To measure cognitive ability, respondents took four subtests of the CFT (Culture Fair Test), which is a widely used and well validated cognitive test battery that captures non-verbal (fluid) intelligence as a proxy for general cognitive ability.<sup>11</sup> We combine the four subtests to form an overall measure of cognitive ability ( $\alpha = 0.79$ ). Summary statistics for all of the measures we analyze in this paper, broken out by zygosity and gender, are provided in the *Online Appendix*. It is worth noting that our psychological measures appear to capture different

elements of personality. Indeed, a correlation matrix showing the interrelationships (available in the *Online Appendix*) among the traits, indicates that the correlation values are generally small to modest (all of the correlation values are under  $r = 0.30$  with the exception of two—the correlation between neuroticism and self-efficacy is  $-0.40$  and the correlation between conscientiousness and self-efficacy is  $0.39$ ). If our personality measures were capturing the same elements of personality, we would expect to see very high correlations between the traits.

### **Analysis and results**

Our analysis is comprised of two steps. First, we estimate univariate twin models to determine how much of the variation in social trust, the Big Five personality traits, self-efficacy, and cognitive ability can be attributed to genetic and environmental factors. A twin study leverages the fact that monozygotic (MZ) twins share 100% of their genes while dizygotic (DZ) twins share on average 50% of their genes. By comparing the trait similarity among MZ twin pairs to that of DZ twin pairs, we can obtain an estimate of the degree to which genes influence that trait.<sup>12</sup> More formally, the univariate twin model assumes that the *variance* in an observed trait can be partitioned into additive genetic factors (A), environmental factors which are shared or common to co-twins (C), and unique environmental factors (E).<sup>13</sup> This is the so-called ACE model.<sup>14</sup> Common environment includes the family environment in which both twins were raised and any other factor to which both twins were equally exposed. In contrast, the unique environment includes influences that are experienced individually. The role of genes and environment are not measured directly but their influence is inferred via their effects on the covariances of twin siblings (Neale & Cardon, 1992).<sup>15</sup>

Second, to estimate how much of the *covariation* between social trust and each of the psychological traits we study can be attributed to the same genetic source, we utilize a Cholesky decomposition model (Martin & Eaves, 1977).<sup>16</sup> The parameter estimates generated by this bivariate model can be used to construct quantities of interest. The genetic correlation quantifies the degree to which the genetic endowment of two traits covary. A correlation of 0 means that the two traits are influenced by completely different genes and a correlation of 1 (or  $-1$ ) means the same genes influence both traits. Another meaningful quantity is the percentage of the phenotypic correlation between two traits that can be explained by additive genetic factors.

Before discussing our results, we note that all of our analyses are based on complete same-sex twin pairs reared together with non-missing responses for social trust and the seven psychological traits of interest. In addition, all measures are residualized of birth year, gender, and cohort.<sup>17</sup> As an initial way of examining heritability, Table 2 presents within-twin-pair correlations for the measure of social trust and the seven psychological traits of interest. Correlations are significantly higher among MZ twins than DZ twins for all traits. Thus, as expected, social trust and the psychological traits considered here seem to have a heritable component. A more sophisticated way of examining heritability is to use univariate models. The univariate estimates of heritability are shown in Table 3. The heritability estimate for the measure of social trust is 0.30 and is significantly different from zero at the 5% level. This estimate is in line with the majority of the previously published heritability estimates described above. We note that the point estimate

**Table 2.** Correlations for MZ and DZ twins.

	MZ	DZ	Difference	<i>P</i> -value
Social Trust	0.44 [0.39, 0.49]	0.28 [0.21, 0.34]	0.16 [0.08, 0.24]	0.00
Extraversion	0.43 [0.38, 0.49]	0.03 [-0.03, 0.09]	0.41 [0.32, 0.49]	0.00
Agreeableness	0.35 [0.29, 0.41]	0.12 [0.05, 0.18]	0.23 [0.14, 0.32]	0.00
Conscientiousness	0.40 [0.34, 0.46]	0.07 [0.01, 0.14]	0.33 [0.24, 0.41]	0.00
Openness	0.38 [0.32, 0.44]	0.16 [0.09, 0.22]	0.22 [0.13, 0.32]	0.00
Neuroticism	0.41 [0.35, 0.47]	0.10 [0.04, 0.16]	0.32 [0.23, 0.39]	0.00
Cognitive Ability	0.66 [0.59, 0.71]	0.43 [0.38, 0.48]	0.22 [0.15, 0.30]	0.00
Self-Efficacy	0.30 [0.24, 0.36]	0.13 [0.06, 0.20]	0.17 [0.07, 0.26]	0.00

Notes: Bootstrapped correlations and 95% confidence intervals for MZ and DZ twins, the difference between the two correlations, and a *P*-value associated with a (one-sided) test of the hypothesis that the MZ correlation is higher than the DZ correlation.

for common environment is 0.14 and is significantly different from zero at the 5% level. The estimate for the unique environment is much larger than the estimate for common environment (0.57) and is also statistically significant  $p < 0.05$ . In terms of the psychological traits, we find that the heritability estimates for all of the Big Five personality traits are significant at the 5% level and range from 0.35 to 0.38. These estimates are slightly lower than typical estimates of heritability for the Big Five traits, but they are still in the same neighborhood as previous estimates reported in the personality literature (Jang et al., 1996; Loehlin et al., 1998; Riemann, Angleitner, & Strelau, 1997). For all of the Big Five traits, the common environment estimates are zero and not statistically significant, which is consistent with previous work on the genetic basis of personality (Jang et al., 1996; Loehlin et al., 1998). Both self-efficacy and cognitive ability are heritable as well. The heritability estimate for self-efficacy is 0.29 ( $p < 0.05$ ) and the heritability estimate for cognitive

**Table 3.** Heritability estimates for social trust, the Big Five personality traits, cognitive ability, and self-efficacy.

	Heritability	Common environment	Unique environment
Social Trust	0.30 [0.15, 0.44]	0.14 [0.01, 0.25]	0.57 [0.52, 0.62]
Extraversion	0.38 [0.33, 0.43]	0.00 [0.00, 0.02]	0.62 [0.57, 0.67]
Agreeableness	0.35 [0.28, 0.40]	0.00 [0.00, 0.04]	0.65 [0.60, 0.71]
Conscientiousness	0.37 [0.32, 0.42]	0.00 [0.00, 0.27]	0.63 [0.58, 0.68]
Openness	0.38 [0.30, 0.43]	0.00 [0.00, 0.06]	0.62 [0.57, 0.67]
Neuroticism	0.38 [0.32, 0.42]	0.00 [0.00, 0.04]	0.62 [0.58, 0.67]
Cognitive Ability	0.55 [0.45, 0.66]	0.14 [0.04, 0.23]	0.31 [0.28, 0.34]
Self-Efficacy	0.29 [0.18, 0.35]	0.00 [0.00, 0.09]	0.71 [0.65, 0.76]

Notes: Parameter estimates and 95% confidence intervals in brackets are shown for a univariate ACE model.

ability is 0.55 ( $p < 0.05$ ). These estimates are very similar to those reported in previous studies (Dawes et al., 2014; Oskarsson et al., 2015). We note that the common environment estimate for self-efficacy is zero and is not significant at the 5% level. The common environment estimate for cognitive ability is 0.14, which is significant at  $p < 0.05$ . This estimate is similar to what was reported by Oskarsson et al. (2015) and Dawes et al. (2014). Both of those studies found that the common environment estimate for cognitive ability was 0.12, though it was not statistically significant in either analysis.

Before moving on to the bivariate models, it is worth noting that the heritability estimate for social trust is fairly close to the heritability estimates for the Big Five personality traits.<sup>18</sup> Given the similarities, one might infer that social trust is essentially a personality trait. However, we tend to agree with Mondak et al. (2017) that the attitudinal approach to measuring social trust, which we use in this paper, ‘provides data one step removed from personality’. Importantly, they note that ‘although we expect attitudinal measures to be correlated with trait measures of trust, it is conceivable that factors other than personality also influence respondents’ answers. To provide a valid measure of trust as a personality trait, a scale *should capture personality, and only personality*’ (p. 146). Indeed, previous research supports the idea that under some circumstances, social trust can be influenced by factors like an individual’s recent experiences or news stories (Mondak et al., 2017). Research has typically found that personality traits are remarkably stable, even over long periods of time, and are usually not moved by recent events or experiences (Gerber, Huber, Doherty, & Dowling, 2013).

The second step in our analysis quantifies the amount of the covariation between social trust and each of the psychological traits that can be attributed to a common genetic source. As a starting point, Table 4 presents the correlations between social trust and the seven psychological traits of interest. The correlations are small to moderate, ranging from 0.06 to 0.25 in absolute value. We find that six of the traits (extraversion, conscientiousness, agreeableness, openness, and cognitive ability, and self-efficacy) are positively correlated with social trust and that one trait (neuroticism) is negatively correlated with trust. We expected positive relationships between all of the traits and social trust except neuroticism and conscientiousness. Thus, our findings are largely in line with the expectations outlined above. The only unanticipated finding is that conscientiousness is positively correlated with social trust, though the correlation value is fairly small ( $r = 0.07$ ). Although we expected a negative relationship based on theory and several previous studies (Dinesen & Bekkers, 2017; Freitag & Bauer, 2016), we note that conscientiousness was positively correlated with trust in the Hiraishi et al. (2008) study described above. In terms of the magnitude of the correlation values, we find that the largest correlations

**Table 4.** Phenotypic correlations (and 95% confidence intervals) between each psychological trait and dependent variable.

	Social trust
Extraversion	0.09 [0.06, 0.12]
Conscientiousness	0.07 [0.04, 0.10]
Agreeableness	0.25 [0.22, 0.28]
Openness	0.06 [0.03, 0.09]
Neuroticism	-0.14 [-0.17, -0.11]
Cognitive Ability	0.21 [0.18, 0.24]
Self-Efficacy	0.10 [0.07, 0.13]

are between agreeableness ( $r = 0.25$ ), cognitive ability ( $r = 0.21$ ), and neuroticism ( $r = -0.14$ ). Oskarsson et al. (2015) have noted that ‘When the phenotypic relationships are weak, the bivariate model requires very large samples to be adequately powered. Therefore, we limit further analyses to those relationships that had at least moderately strong correlations equal to or greater than 0.15’ (p. 659). Given that agreeableness and cognitive ability exceed the recommended threshold of 0.15 (and neuroticism is very close at  $-0.14$ ), we focus the rest of our analysis on these three psychological traits.<sup>19</sup>

The genetic and environmental correlations and the percentage of the total correlation due to genetic and environmental factors are presented in top and bottom panel of Table 5, respectively. We denote the genetic correlation as  $r_g$ , the common environment correlation as  $r_c$ , and the unique environment correlation as  $r_e$ . We denote the percentage of correlation accounted for by genetic factors as  $\%r_g$ , the percentage of correlation accounted for by common environment as  $\%r_c$ , and the percentage of the correlation accounted for by unique environment as  $\%r_e$ . By construction  $\%r_g$ ,  $\%r_c$ ,  $\%r_e$  must sum to one but  $r_g$ ,  $r_c$ ,  $r_e$  do not (necessarily) sum to one. Formal derivations of each quantity are presented in the *Online Appendix*. We find that the genetic correlation between agreeableness and social trust is 0.50 ( $p < 0.05$ ). Table 5 indicates that genetic factors make up 64.40% of the correlation between agreeableness and social trust. When it comes to neuroticism, we find that the genetic correlation between this trait and social trust is  $-0.26$  ( $p < 0.05$ ). Genetic factors make up 59.73% of the correlation between neuroticism and social trust. Interestingly, the results in Table 5 for cognitive ability indicate that there is overlap between this trait and social trust, but the overlap is due to common environment. As we noted when discussing the univariate results in Table 3, the common environment estimates for both social trust and cognitive ability, though smaller than the genetic or unique environment estimates, were statistically significant at  $p < 0.05$ . The genetic correlation between cognitive ability and social trust is not statistically significant, though it is very close to being significant at the 5% level. The common environment correlation ( $r_c$ ) is 0.79 and is statistically significant at the  $p < 0.05$  level. The percentage of correlation

**Table 5.** Bivariate Cholesky ACE models.

	Social trust		
	$r_g$	$r_c$	$r_e$
Agreeableness	0.50 [0.28, 0.76]	1.00 [-1.00, 1.00]	0.10 [0.04, 0.16]
Neuroticism	-0.26 [-0.51, -0.01]	-1.00 [-1.00, 1.00]	-0.04 [-0.10, 0.02]
Cognitive Ability	0.20 [-0.02, 0.44]	0.79 [0.28, 1.00]	0.04 [-0.02, 0.10]
Agreeableness	$\%r_g$ 64.40 [31.00, 94.59]	$\%r_c$ 10.45 [-12.24, 36.40]	$\%r_e$ 25.15 [11.13, 39.47]
Neuroticism	59.73 [2.99, 113.69]	2.99 [-18.87, 67.63]	22.21 [7.31, 42.25]
Cognitive Ability	37.78 [-3.03, 80.46]	54.75 [17.87, 89.71]	7.48 [-5.81, 19.95]

Notes: Top panel: Genetic ( $r_g$ ), shared environment ( $r_c$ ), and unique environmental ( $r_e$ ) correlation and 95% CIs from bivariate Cholesky ACE models of social with the Big Five personality traits agreeableness and neuroticism as well as cognitive ability. Bottom panel: Percentage of total correlation due to Genetic, Shared Environment, and Unique Environmental Correlation and 95% CIs from Bivariate Cholesky ACE models of social trust with the Big Five personality traits agreeableness and neuroticism as well as cognitive ability.

between cognitive ability and social trust accounted for by common environment is 54.75%. It is interesting to note that Oskarsson et al. (2012) found that there was significant genetic overlap between general intelligence and social trust in their sample of Swedish twins. They did not find evidence of a statistically significant common environment correlation. It is important to point out, though, that their study is not directly comparable because they only had a measure of intelligence for males in their sample. We have a measure of cognitive ability for both males and females. In addition, they used different measures than we employ here. Thus, the different findings across studies could be due to differences in samples or measures. Of course, it is also possible that the different study contexts (Sweden versus Germany) also influenced the results. Ultimately, additional studies will be necessary in order to further examine the nature of the relationship between cognitive ability and social trust.

## Conclusion

In this paper, we were interested in better understanding generalized social trust. Given the importance of this orientation to a variety of outcomes, it is critical to learn about the underpinnings of social trust. We made a number of contributions to the literature on social trust. First, using a newly-released dataset on German twin pairs, we were able to replicate previous studies on the heritability of social trust. Overall, we found that social trust is moderately (30%) heritable. This is consistent with much of the previous research on the biological origins of social trust. Second, we examined the amount of genetic and environmental overlap between social trust and a number of important psychological traits. We found that agreeableness, neuroticism, and cognitive ability were moderately correlated with social trust. However, there is a large amount of genetic overlap between agreeableness and social trust. Neuroticism and social trust also share the same genetic etiology. When it comes to cognitive ability, we found that the correlation between this trait and social trust was due to common environment. There was no significant genetic overlap between cognitive ability and social trust in our dataset. One previous study (Oskarsson et al., 2012) found evidence of genetic overlap between intelligence and social trust, although the different findings across studies could stem from sample or measurement differences. We encourage future studies on the link between genes, cognitive ability, and social trust.

Although significant genetic correlations could be interpreted as evidence of psychological traits *mediating* the relationship between genes and social trust (this would imply a causal ordering), it is also possible that psychological traits and social trust may share the same underlying genetic mechanism but not share a causal relationship (Posthuma et al., 2003). The latter scenario, known as *pleiotropy*, implies that genetic factors are a confounder. Interestingly, numerous previous studies have failed to find much evidence of mediation. Indeed, when phenotypic correlations are small or modest, as they were in the above analyses, it is clear that there cannot be too much mediation. Given our findings, we encourage future researchers to examine other psychological traits that are heritable and related to social trust. It is important to recognize that the Cholesky model we use in this paper does not allow us to adjudicate between different types of possible relationships, but the collection of additional waves of the TwinLife Study, which will provide data collected at different points in time, may enable researchers

to better understand the nature of the relationships between genes, psychological traits, and generalized trust.

Our results have a number of important implications, some of which may be of interest to civic organizations that want to increase levels of social trust.<sup>20</sup> Indeed, given that social trust enhances cooperation and increases the odds that people participate in civic life, there are good reasons why society might want to develop interventions (e.g. in schools) designed to increase generalized trust. Although our analysis showed that individual differences (e.g. genes, psychological traits) influence generalized trust, we want to make it clear that our results do not mean that people are guaranteed to behave or feel a certain way. Individual differences, like personality traits, may *predispose* people to hold a certain orientation but they are *not deterministic*. Importantly, we note that knowing which individual differences influence social trust might be helpful in designing interventions that appeal to people whose attributes initially predispose them to feel very little social trust. For example, certain messages or programs might be very effective at cultivating social trust for people with a particular trait or set of traits but ineffective for people with a different trait or set of traits.<sup>21</sup> A number of experimental studies have started to consider the extent to which receptivity to messages and voter mobilization appeals is influenced by personality traits and biological attributes (Gerber, Huber, Doherty, Dowling, & Panagopoulos, 2011; Settle, Dawes, Loewen, & Panagopoulos, 2017; Weinschenk & Panagopoulos, 2014).

There are a number of different avenues for future research based on the results presented above. First, and related to the discussion above, it will be important for future researchers to examine the interplay between biological, psychological, and environmental factors. Do psychological or biological traits interact with one's social experiences or the institutional contexts within which one lives to influence levels of social trust? Research on the moderating role of environmental factors presents an exciting opportunity for future scholars. It would be especially interesting if researchers could partner with civic organizations interested in promoting social trust to develop and assess the effect of different interventions (e.g. school-based programs, community development initiatives, etc.) on individuals. In addition, existing research on the role of environmental factors like ethnic diversity (Dinesen & Sønderskov, 2015; Gundelach & Freitag, 2014), political institutions (Rothstein & Stolle, 2008), and economic inequality (Uslaner & Brown, 2005) in shaping generalized trust provides an opportunity to study the interaction between individual differences and environmental factors. Second, we strongly encourage the collection of new datasets that contain information on biological factors, psychological traits, and orientations like social trust. Additional datasets could be used to replicate existing studies, including this one, but could also be used to test new hypotheses altogether. It would be especially interesting to collect data across different contexts and in different time periods in order to get a sense of whether relationships vary across time and space or whether they are fairly consistent.

## Notes

1. Generalized social trust is also sometimes called social trust, generalized trust, general trust, general social trust, and interpersonal trust. We use these terms interchangeably throughout this paper. We should note that general trust and particularized trust are distinct concepts. As



Freitag & Bauer (2016) note, 'Particularized trust is trust at close social range and is exhibited toward people the individual personally knows from everyday interactions (e.g. friends, neighbors, and co-workers). Generalized trust, on the other hand, is a rather abstract attitude toward people in general, encompassing people beyond one's immediate familiarity, including strangers (e.g. random people one encounters on the street, etc.). Generalized trust differs from particularized trust in that it deals with unknown groups and does not predominantly depend upon specific situations (Freitag & Bauer, 2013; Stolle, 2002)' (p. 469). We also note that generalized social trust is different from political trust, which typically focuses on citizens' confidence in political institutions.

2. One additional, albeit fairly minor, contribution we are able to make to the literature is to provide a more comprehensive test of previous findings on the connection between genes, cognitive ability, and trust. Oskarsson et al. (2012) only had a measure of cognitive ability for males, but our dataset contains measures of cognitive ability for males and females. We should also note that we have different measures than previous studies. So, for example, our measure of extraversion is based on a different set of survey items than Oskarsson et al. (2012) or Hiraishi et al. (2008) use. Again, this is a fairly minor contribution but is worth pointing out.
3. There have also been concerns about circularity when it comes to using openness to predict political ideology, since some measures of openness reference to politics (e.g. *I tend to vote for liberal political candidates*). In general, the approach to avoiding such concerns is to construct personality measures that omit any items that might be similar to the dependent variable of interest (see, e.g. Verhulst, Hatemi, & Martin, 2010).
4. Mondak et al. (2017) argue that attitudinal measures of generalized trust, which we use in this paper, are different from measures of trust as a personality trait. They note that 'In psychological research, personality traits typically are measured with data pertaining to an individual's patterns of thought and behavior. In measuring trust as a trait, the analyst would administer a self-report protocol, with respondents asked the extent to which they 'trust others', 'trust what people say', 'distrust people', and so on. In contrast, survey-based measures of generalized trust ask about respondents' views regarding the trustworthiness of others. For example, items included in the General Social Survey ask respondents whether they feel that 'most people would try to take advantage of you', and 'most people can be trusted'. People who score high in trust as a personality trait should tend to express the view that other people should be trusted, meaning that attitudinal measures of the perceived trustworthiness of others should be related to trust as a trait. *Still, the attitudinal approach provides data one step removed from personality.* We see two reasons for concern. First, we are unaware of efforts to validate attitudinal measures of generalized trust as representations of trust as a personality trait. Second, although we expect attitudinal measures to be correlated with trait measures of trust, it is conceivable that factors other than personality also influence respondents' answers. To provide a valid measure of trust as a personality trait, a scale should capture personality, and *only personality*. Responses on attitudinal measures may be influenced by factors beyond personality, such as an individual's recent experiences or news stories the person has seen. In light of this concern, if generalized trust is to be taken as a measure of personality, we see it as preferable that data be drawn using adjectival self-rating scales' (p. 146, *italics added for emphasis*).
5. Dinesen et al. (2014) note, for example, 'To avoid circular reasoning and inflation of the relationship between Agreeableness and trust due to inclusion of very similar indicators in the constructs, we estimate models including two versions of the Agreeableness scale: one with the full scale and one with a scale with the two items akin to the items in the trust scale removed (for a similar approach, see Hiraishi et al., 2008)'.
6. Dinesen et al. (2014) note that 'We think that people scoring high on Neuroticism, due to their anxious and uneasy nature, would be more likely to see other people as potential threats and hence be less likely to trust them'.
7. Twin families are drawn from local resident registers in communities with at least 5000 inhabitants in Germany. Details on the sampling procedure and representativeness of the TwinLife

sample are available here: <https://pub.uni-bielefeld.de/publication/2913250>. The twin families are recognized as such if two same-sex people with the same date of birth lived in the same household. Then, it was checked whether the selected persons were twins. Zygosity was determined by questionnaire information and corrected by result of the DNA test. Additional details on the determination of zygosity can be found at the following link: <https://pub.uni-bielefeld.de/publication/2909616>. Only twins of the same sex are surveyed in order to prevent distortions due to gender differences. Moreover, only such pairs that have grown up or are growing up in the same family are studied.

8. Overall, in the data we analyze (people who have non-missing responses on all of the measures we examine in this paper), we have 430 respondents born in 1990, 470 respondents born in 1991, 471 respondents born in 1992, 532 respondents born in 1993, 998 respondents born in 1997, and 1056 respondents born in 1998.
9. The researchers who designed the TwinLife Study selected measures to include in the study based on preexisting batteries (e.g. Big-Five Inventory-SOEP or BFI-5) and studies. Documentation on where measures and concepts included in the TwinLife Study are derived from can be found at the following link: <https://dbk.gesis.org/dbksearch/sdesc2.asp?no=6701&db=e&doi=10.4232/1.12665>
10. These reliability estimates are similar to those reported by Hahn, Gottschling, and Spinath (2012), who use similar measures and data from a German sample. They report the following reliabilities:  $\alpha = 0.76$  (Extraversion),  $\alpha = 0.60$  (Conscientiousness),  $\alpha = 0.58$  (Openness),  $\alpha = 0.66$  (Neuroticism), and  $\alpha = 0.44$  (Agreeableness). For each personality trait, we included items that maximized the alpha score (using the item command in Stata's alpha analysis). Thus, the alpha scores we report represent the maximum level of reliability we could achieve given the personality items asked in the TwinLife Study.
11. The four subtests focus on (1) Figural Reasoning, (2) Figural Classification, (3) Matrices, and (4) Reasoning. Correct answers are coded as a 1 and wrong answers are coded as a 0. Sum scores for each subtest are computed as sum of all correctly solved items. The first three subtests contain 15 items and the fourth subtest contains 11 items.
12. Identification of the univariate twin model based on MZ and DZ twins reared together requires the so-called *Equal Environments Assumption (EEA)*. A violation of the EEA leads to an upward bias in heritability and a downward bias in common environment estimates. Several recent studies attempting to test for upward bias in the heritability of political attitudes have failed to find evidence of an EEA violation (Hatemi et al., 2009, 2010; Littvay, 2012; Smith et al., 2012). A more detailed discussion of the EEA is contained in the *Online Appendix*.
13. Measurement error will be subsumed under the estimate of E.
14. For a primer of biometric modeling geared for political scientists see Medland and Hatemi (2009).
15. A more detailed description of the univariate model is presented in the *Online Appendix*.
16. A more detailed description of the bivariate model is presented in the *Online Appendix*.
17. All twin models in this paper are estimated using the Mx software package (Mx-OSX version 1.65f) (Neale, Boker, Xie, & Maes, 2003). Twins born between 1990–1993 are in one cohort and twins born in 1997/1998 are in another cohort. Since the questions we analyze in this paper were only asked of the two oldest cohorts in the sample, we use a dummy variable to measure cohort. Birth year can take on one of six different values: 1990, 1991, 1992, 1993, 1997, or 1998.
18. Although as we note above, the estimate for common environment is statistically significant for social trust, but not for any of the Big Five traits (which is what research in personality psychology on the Big Five has consistently found).
19. Bivariate results for extraversion and self-efficacy, which are correlated with social trust in the expected direction and significant at the 5% level, are provided in the *Online Appendix*. We also provide the results for the remaining traits in case readers are interested.
20. See: [https://assets.publishing.service.gov.uk/media/57a089fded915d3cfd00051e/hdq941\\_2.pdf](https://assets.publishing.service.gov.uk/media/57a089fded915d3cfd00051e/hdq941_2.pdf)
21. It is important to recognize that studies have repeatedly shown that personality traits are remarkably stable over time. Thus, those interested in designing interventions to enhance social trust would be much better served by thinking about the type of information that

would resonate well with people who have particular personality traits rather than trying to alter personality traits.

## Disclosure statement

No potential conflict of interest was reported by the authors.

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