PNAS RESEARCH ARTICLE | PSYCHOLOGICAL AND COGNITIVE SCIENCES

Meta-analytic relations between personality and cognitive ability

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Edited by Daniel J. Benjamin, University of California, Los Angeles, CA; received August 22, 2022; accepted March 24, 2023 by Editorial Board Member Michael S. Gazzaniga

Cognitive ability and personality are fundamental domains of human psychology. Despite a century of vast research, most ability–personality relations remain unestablished. Using contemporary hierarchical personality and cognitive abilities frameworks, we meta-analyze unexamined links between personality traits and cognitive abilities and offer large-scale evidence of their relations. This research quantitatively summarizes 60,690 relations between 79 personality and 97 cognitive ability constructs in 3,543 meta-analyses based on data from millions of individuals. Sets of novel relations are illuminated by distinguishing hierarchical personality and ability constructs (e.g., factors, aspects, facets). The links between personality traits and cognitive abilities are not limited to openness and its components. Some aspects and facets of neuroticism, extraversion, and conscientiousness are also considerably related to primary as well as specific abilities. Overall, the results provide an encyclopedic quantification of what is currently known about personality–ability relations, identify previously unrecognized trait pairings, and reveal knowledge gaps. The meta-analytic findings are visualized in an interactive webtool. The database of coded studies and relations is offered to the scientific community to further advance research, understanding, and applications.

personality | cognitive ability | meta-analysis | intelligence | Big Five

Personality and cognitive ability are principal classes of psychological differences (1). They encompass potent predictors of important behaviors and outcomes (2, 3), including what activities people prefer (4), what environments they gravitate toward (5), who they are drawn to (6), and how well they perform their work (7). They are also key determinants of physical, mental, and even financial health (8, 9). Although considerable research has examined the correlates and consequences of cognitive abilities and personality traits independently, much less is known about their connections.

In fact, with a few notable exceptions (e.g., openness), researchers mostly consider them to be unrelated (e.g., refs. 10 and 11). However, constellations of personality traits and cognitive abilities are *jointly* important components of individuality. This study aims to comprehensively summarize personality–ability relations among individuals. In this vast empirical survey, we meta-analytically quantify the connections between cognitive abilities and personality traits by cumulating findings from the past 100 y of research.

Focusing solely on either cognitive abilities or personality limits research, understanding, and application. Quantifying their connections is important because if cognitive abilities (i.e., what an individual is cognitively capable of) and personality traits (i.e., what an individual typically does) substantially covary, then work omitting constructs from one of these domains would yield biased results, referred to as the omitted variables problem (12, 13). Scientific theories, research studies, and behavioral interventions that are based on assumed independence would be deficient and misleading. Meaningful relations between these domains would also suggest potential common etiologies.

Significance

Personality and cognitive ability are consequential domains of human individuality. More than 100 y of research has examined their connections, and yet most ability–personality relations remain unknown. We quantitatively synthesized 1,325 studies including millions of individuals from more than 50 countries to identify novel, considerable ties between personality traits and cognitive abilities. Neuroticism facets (e.g., suspiciousness, depression) were negatively related to most cognitive abilities including non-invested (e.g., fluid reasoning) and invested abilities (e.g., knowledge). Extraversion's activity facet had sizable, positive relations with several non-invested (e.g., retrieval fluency and processing abilities) and invested abilities. Conscientiousness' industriousness and agreeableness' compassion aspects positively related to most invested abilities. Previous focus on high-level relations obscured understanding of individual differences and their applications.

Theoretical and Empirical Background

Personality traits are relatively stable "patterns of thoughts, feelings, and behaviors" (14, p. 390) "that consistently distinguish people from one another in terms of their basic tendencies" (15, p. 1523). Cognitive abilities involve perceiving, processing, manipulating, and applying information to drive decisions and actions. These coinfluential domains energize action toward goal achievement and help generate new goals, interpretations, and strategies as goals are attained or obstructed or as behaviors are deemed productive/unproductive.

Many individual studies have incidentally reported relations between personality traits and cognitive abilities, with only some focusing on them. Primary studies are also limited by their samples and measures (16). A few meta-analyses have summarized available research (e.g., refs. 17–21). However, these efforts were limited in the scope of their

Author contributions: K.C.S. and D.S.O. designed research; K.C.S. and D.S.O. performed research; K.C.S. analyzed data; and K.C.S. and D.S.O. wrote the paper.

The authors declare no competing interest.

This article is a PNAS Direct Submission. D.J.B. is a guest editor invited by the Editorial Board.

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This article contains supporting information online at https://www.pnas.org/lookup/suppl/doi:10.1073/pnas.2212794120/-/DCSupplemental.

Published May 30, 2023.

investigations [e.g., focused on one factor of the Big Five (18, 19) or a few abilities (21)], restricted in the sources of their meta-analytic data (e.g., mostly relying on published research), deficient in constructs included (e.g., omitting important personality traits and cognitive abilities), and hampered by limited models or understanding of the hierarchical structure of personality traits and abilities. Nevertheless, these works established two main conclusions. First, cognitive abilities were moderately associated with a variety of openness-related traits (17, 19) but appeared to have weak relations with other personality characteristics (18). Second, investment of intelligence into acquired knowledge (i.e., invested abilities) was found to require a hungry mind (i.e., openness traits) and interest in the domain of knowledge to be acquired (17, 19). Thus, invested abilities displayed larger relations with openness traits, especially its intellect, non traditional,* need for cognition, and openness to ideas facets. These findings shed light on how knowledge is acquired through a process consistent with the investment theory (22) of intelligence, which specifies how the brain's general pattern-perceiving ability is directed at different learning tasks (23). This investment process underpins the emergence of knowledge acquisition trait complexes (17) and intellectual engagement (19). Yet, behavioral activation theories implicate other Big Five dimensions, especially neuroticism, conscientiousness, and extraversion in self-regulation (24), as discussed next.

Self-regulation for behavioral activation and inhibition (25, 26) is likely to rely on both cognitive abilities and personality tendencies. For example, emotions can interfere with cognitive processing, suggesting a role for neuroticism. Similarly, conscientiousness and extraversion can activate individuals toward task achievement and interpersonal engagement. In all these cases, higher intelligence may help individuals more clearly see how to leverage the resources in the environment to make progress toward goals.

Many personality–ability connections, especially those related to extraversion, neuroticism, conscientiousness, and agreeableness, have been overlooked in the literature because investigations have not probed at all levels of the personality and ability hierarchies. Developments in personality models during the past two decades have led to a more fine-grained, hierarchical taxonomy of the personality domain (27) that builds on the well-established Big Five personality factors and distinguishes constructs by hierarchical level (e.g., factor, aspect, facet). The same applies to the cognitive ability domain, which includes general mental ability as well as primary abilities and their specific abilities. We report findings for all levels of these hierarchies because although these variables are hierarchically related, their general, primary, and specific ability loadings vary. Indeed, previous research has found that lower level relations are sometimes masked in higher order constructs (28, 29). Given the utility of general as well as specific abilities and traits, we present results across all levels of both hierarchies. As such, our research is relevant to scholars who study general mental ability as well as those who focus on primary and specific abilities (e.g., those studying language acquisition are interested in verbal abilities and even different sub-dimensions of verbal abilities). Similarly, it is pertinent to those studying the Big Five factors (e.g., extraversion) as well as those who focus on their aspects and facets (e.g., compassion aspect of agreeableness) as well as compound traits (e.g., self esteem, locus of control, proactive personality). More detailed descriptions of these hierarchies and domains are provided in *SI Appendix*, *Supplementary Text, Extended Technical Description of Cognitive Abilities and Extended Technical Description of Personality Traits*, p. 4. See *SI Appendix*, Figs. S1 and S2 for visual depictions of their hierarchies.

*The non traditional personality facet represents a tendency to question dogma in applying and following societal conventions, and to be open to unconventional values and practices.

The Current Study

This research seeks to comprehensively quantify personality–ability relations to build a foundational catalog. We: 1) meta-analyze previously unexamined personality–ability relations and 2) investigate relations across levels of the personality and cognitive ability taxonomies. These investigations reveal gaps in the scholarly literature (i.e., understudied relations) that should motivate research attention.

We systematically and quantitatively estimated relations for 79 personality constructs tied to the Big Five framework as well 97 cognitive abilities, most of which have not been previously meta-analyzed. Specifically, we add 84 ability constructs and 28 personality constructs beyond previous works. Thus, the current research considers the full spectrum of personality traits and cognitive abilities (30–32) to quantify cross-domain relations using well-supported taxonomies of both personality and ability domains and offers, based on effect sizes, a 24-fold expansion on previous psychometric meta-analyses.

In all, we meta-analytically quantify 3,543 ability–personality relations, most (93%) of which have *not* been previously meta-analytically estimated at the construct level. Each of these new and unique meta-analyses contributes to basic and applied disciplines that utilize personality and ability constructs and measures in their theories, research, and applications. The results provide an encyclopedic quantification of personality–ability relations at all levels of their hierarchies, identify previously unrecognized trait pairings, reveal important gaps in knowledge, and update previous findings.

Results

Database Description. Our meta-analytic results are based on 1,976 independent samples and 60,690 personality–ability correlations. Each meta-analysis only contained independent correlations. Samples came from over 50 countries (see *SI Appendix*, Table S1 for full list). The average participant age ranged from 12.0 to 100.3 y (*SI Appendix*, Figs. S3 and S4 for age distributions). The average sample composition was 54.1% male. Raw datasets (41%) and peer-reviewed journal articles (29%) were the two largest contributing sources (*SI Appendix*, Table S2 details the sources of the effect sizes in the database and *SI Appendix*, Table S3 the proportions of participant types).

Complete quantitative results, including point estimates of correlations, credibility intervals that indicate true variability in the distribution of correlations in each meta-analysis, and CIs that indicate the precision of each mean meta-analytic estimate, are reported in *SI Appendix*, Tables S4–S82. *SI Appendix*, Table S83 details how the scope of the current analyses compares to previous meta-analytic investigations. For the small portion of relations examined both in this research and previous meta-analyses, *SI Appendix*, Tables S84–S88 provide comparisons of the point estimates.

Overview of Relations and Gaps. The primary contribution of this manuscript is providing an expansive quantitative catalog of personality–ability relations. Therefore, it was important to capture relations based on whatever number of studies were available. Some of the analyses in the tables are based on data arising from small numbers of samples or individuals. We do not

interpret or discuss findings based on small K or N (i.e., $K < 10$ or $N < 1{,}000$). The findings highlight: 1) personality and cognitive ability relations are not limited to the openness-related traits, 2) distinguishing constructs by hierarchical level (e.g., aspect, facet for personality; primary, specific ability for abilities) matters since their relations are not isomorphic, and 3) there are many understudied personality–ability relations.

Magnitude of Relations. Several personality–ability relations were sizable. We interpreted magnitudes using contemporary behavioral science benchmarks (33, p. 156): an effect of $r = .05$ is "very small," $r = .10$ is "small," $r = .20$ is "medium," and an effect size of $r = .30$ is "large." The same benchmarks apply to positive and negative correlations. Using this framework, of 3,543 meta-analytic relations: 5% were large or very large (193 relations greater than or equal to .30), 13% were medium (449 relations in .20 to .30 range), 29% were small but still notable (1,041 relations in .10 to .20 range), 25% were very small (870 relations in .05 to .10 range), and 28% of relations were negligible (990 relations in .00 to .05 range). In line with previous research (21, 34), acquired knowledge (i.e., invested) abilities tended to be more strongly correlated with personality traits than non-invested abilities were. However, 41% of non-invested abilities' relations with personality traits were still above .10 and 12% were above .20. The results for all 3,543 relations are presented in *SI Appendix*, Tables S4–S82, with empty rows indicating where no empirical research was found.

Although previous research has established that personality traits involving openness (e.g., need for cognition) are related to cognitive abilities (19), the links between personality traits and cognitive abilities are not limited to openness-related traits. In fact, 347 other relations with traits that include no element of openness had medium to large correlations (.20 or greater). Furthermore, substantial relations were rarely at the Big Five factor level but rather at the level of aspects, facets, and compound[†] traits. Relations can be visually explored in the interactive webtool (http://stanek.workpsy.ch/interactivewebtool/). The website also contains definitions of each cognitive ability and personality trait and their measures.

Ability–personality relations are also visualized in Figs. 1–3. In these visualizations, meta-analytic correlations (i.e., $\widehat{\rho}$) are only reported in black type if the result is based on at least 10 independent contributing effect sizes or at least 1,000 participants. Gray-filled cells had no usable data. Green-filled cells indicate positive effects, and red-filled cells indicate negative effects. Saturation indicates effect magnitude.

The results below are organized around the Big Five personality traits and describe findings that are statistically reliable (i.e., less prone to sampling error: $K \geq 10$ or $N \geq 1{,}000$). Ninety-five percent CIs indicate the precision of meta-analytic estimates (*SI Appendix*, Tables S4–S82). We do not describe every single one of the 1,942 relations that had a large N or K. Instead, borrowing an approach from second-order meta-analysis (35) to guard against chance relations, we describe important trends in the results by quantitatively synthesizing across related meta-analyses (see Table 1 for mean point estimates of relations and *SI Appendix*, Table S89 for their CIs; Table 1 synthesizes information from Figs. 1–3). When describing the results below, these quantitatively synthesized relations are referenced as mean $\widehat{\rho}$ and include associated mean 95% CIs.

Neuroticism Traits. Neuroticism-related traits involve feeling negative emotions, which interrupt higher cognition (36, 37). Neuroticism's aspects are volatility and withdrawal. Its major facets are anxiety, depression, negative affect, suspiciousness, and uneven tempered. Neuroticism's positive pole—emotional stability—promotes internal psychological stability, regulates negative emotions, and is a core personality trait in self-regulation. It is closely related to healthy self regard, self esteem, and internal locus of control (27).

Generally, neuroticism traits correlate negatively with cognitive abilities. Across abilities, relations at the global neuroticism level were modest (mean $\widehat{\rho}$ = **–.07**,[‡] mean 95% CI [–.11, –.02][§]), but stronger relations emerged at the aspect and particularly facet levels (see Fig. 1; synthesized in Table 1). The results for neuroticism constructs are fully detailed in *SI Appendix*, Tables S4–S15. Comparisons to previous meta-analyses (where available) are presented in *SI Appendix*, Table S84.

Depression, uneven tempered, suspiciousness, and anxiety had sizable, negative relations with the vast majority of non-invested cognitive abilities. Non-invested abilities include all abilities except acquired knowledge (i.e., invested abilities) and general mental ability. These findings may represent enervating effects of neuroticism-related traits. Neuroticism's depression facet is a notable, negative correlate of general mental ability ($\widehat{\rho}$ = **–.18**, 95% CI [–.21, –.14]) as well as many *non-invested* primary[¶] (mean $\widehat{\rho}$ = **–.19**, mean 95% CI [–.26, –.12]) and specific abilities (mean $\widehat{\rho}$ = **–.12**, mean 95% CI [–.18, –.07]). It also had sizable, negative relations with *invested verbal* abilities (mean $\widehat{\rho}$ = **–.18**, mean 95% CI [–.24, –.12]). These findings are in line with longitudinal research indicating steeper cognitive declines for depressed individuals (38).

The uneven tempered facet displayed substantial, negative correlations with cognitive abilities. Relations were especially sizable for acquired knowledge *primary* abilities (mean $\widehat{\rho}$ = **–.29**, mean 95% CI [–.31, –.28]) as well as *specific* verbal and quantitative abilities (mean $\widehat{\rho}$ = **–.27**, mean 95% CI [–.30, –.24]). The average correlation with domain specific abilities was **–.18** (mean 95% CI [–.20, .16]).

Suspiciousness displayed small-to-medium, negative relations with general mental ability ($\widehat{\rho}$ = **–.17**, 95% CI [–.21, –.13]), fluid abilities (mean $\widehat{\rho}$ = **–.15**, mean 95% CI [–.22, –.08]), short term and long term memory abilities (mean $\widehat{\rho}$ = **–.18**, mean 95% CI [–.29, –.07]), perceptual speed ($\widehat{\rho}$ = **–.14**, 95% CI [–.21, –.07]), visualization ($\widehat{\rho}$ = **–.11**, 95% CI [–.17, –.05]), and several specific verbal abilities (mean $\widehat{\rho}$ = **–.24**, mean 95% CI [–.31, –.16]).

Anxiety's relations were weaker (e.g., mean $\widehat{\rho}$ = **–.07** across all abilities, mean 95% CI [–.12, –.03]) and **–.07** with general mental ability (95% CI [–.11, –.04]). Its relations with invested abilities were somewhat larger (mean $\widehat{\rho}$ = **–.12**, mean 95% CI [–.18, –.06]). Anxious individuals tend to experience anxiety in testing situations (39), and test anxiety was more strongly related to most cognitive abilities (mean $\widehat{\rho}$ = **–.21**, mean 95% CI [–.30, –.12]). Numerous studies focus on test anxiety's negative effect on verbal and quantitative test performance (e.g., ref. 40). The results confirm its notable relations with acquired knowledge abilities (mean $\widehat{\rho}$ = **–.23**, mean 95% CI [–.31, –.16]).

[†]Compound traits are interstitial constructs that represent variance from multiple Big Five dimensions (80).

[‡]Throughout this manuscript, the mean $\widehat{\rho}$ provides the average of meta-analytic correlations across a set of meta-analytic findings described in the same sentence (e.g., global neuroticism's relations with all abilities in this example). This was to characterize consistent trends in the data rather than to focus on particular relations.

[§]Throughout the manuscript, mean 95% CIs provide the *average* lower and upper 95% CIs across a *set* of meta-analytic findings described in the same sentence (e.g., average of CIs for global neuroticism across abilities). These characterize trends in CIs.

[¶]For descriptions of primary abilities and specific abilities, see http://stanek.workpsy.ch/cognitive-ability-map/cognitive-ability-taxonomy/ or Stanek and Ones' (27) Table 13.1 (see *SI Appendix*, Fig. S2 of this manuscript for the depiction of their hierarchy). See http://stanek.workpsy.ch/personality-map/personality-taxonomy/ or Stanek and Ones' Tables 13.2 and 13.3 for descriptions of the personality traits (see *SI Appendix*, Fig. S1 of this manuscript for depiction of their hierarchy).

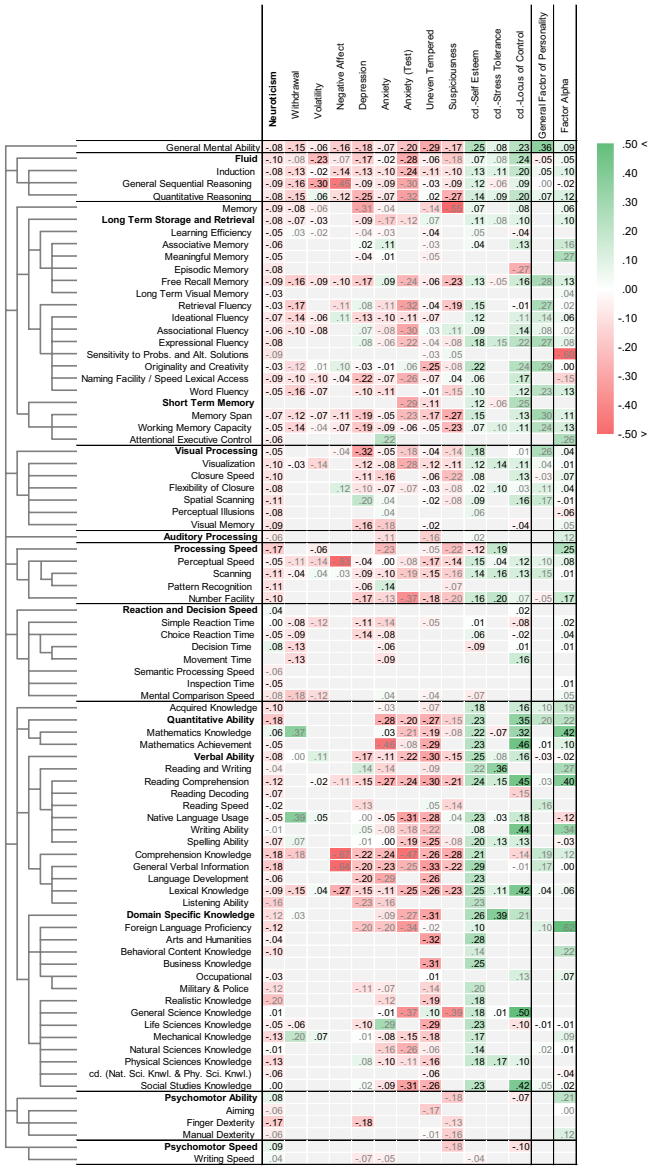

Fig. 1. Meta-analytic relations of neuroticism-related traits, the general factor of personality, and factor alpha with cognitive abilities. *Note.* Dendrogram indicates level of each ability in the abilities' hierarchy (27). "cd." denotes compound traits. Meta-analytic correlations (i.e., $\widehat{\rho}$) are only reported in black type when number of independent effect sizes contributing the specific meta-analysis was ≥10 or the sample was ≥1,000 participants. Gray-filled cells had no usable data. Green-filled cells indicate positive effects, and red-filled cells indicate negative effects. Saturation indicates effect magnitude.

Overall, the findings suggest that self-regulating and sustaining psychological processes, including cognitive performance, tend to be lower among those high on depression, many of whom have difficulties regulating their temper and suspiciousness, and who often experience high levels of anxiety.

The compound personality traits most related to neuroticism include self esteem, stress tolerance, and locus of control.[#] Self esteem had a mean correlation of **.15** across all abilities (mean 95% CI [.12, .18]) and was especially correlated with acquired knowledge constructs (mean $\widehat{\rho}$ = **.21**, mean 95% CI [.19, .23]). Stress tolerance had a mean correlation of **.14** across all abilities (mean 95% CI [−.09, .19]) and was correlated with processing speed abilities (mean $\widehat{\rho}$ = **.15**, mean 95% CI [.10, .19]), verbal abilities (mean $\widehat{\rho}$ = **.16**, mean 95% CI [.05, .27]), and domain specific knowledge abilities (mean $\widehat{\rho}$ = **.19**, mean 95% CI [.15, .23]). Internal locus of control had a mean correlation of **.15** (mean 95% CI [.09, .21]) across all abilities, including fluid abilities (mean $\widehat{\rho}$ = **.18**, mean 95% CI [.07, .29]). Its relations tended to be stronger for acquired knowledge constructs (mean $\widehat{\rho}$ = **.29**, mean 95% CI [.22, .35]).

Agreeableness Traits. Agreeableness-related traits involve getting along with others. They enable attainment of goals via altruism, cooperation, and helpfulness. Agreeableness traits are useful for maintaining the individual in social environments (41). The results for agreeableness constructs are fully detailed in *SI Appendix*, Tables S16–S30. Comparisons to previous meta-analyses (where available) are presented in *SI Appendix*, Table S85.Agreeableness traits had the weakest relations with cognitive abilities. However, its aspects (compassion and politeness) differed in their patterns of relations (see Fig. 2; synthesized in Table 1).

Compassion is willingness to expend energy on non-kin, demonstrating contribution to a social group and weaving a social safety net for the individual. In contrast, politeness focuses on facilitating transactional interactions according to socially prescribed rules for conduct. Compassion and politeness have opposite patterns of relations with cognitive abilities. In general, the former was positively correlated with cognitive abilities and the latter was negatively correlated. Compassion correlated **.26** with general mental ability (95% CI [.24, .27]). Compassion's relations with processing speed abilities were positive and small to medium (mean $\widehat{\rho}$ = **.14**, mean 95% CI [.12, .16]). Its more noteworthy relations tended to be with the set of acquired knowledge abilities (mean $\widehat{\rho}$ = **.24**, mean 95% CI [.23, .24]).

In stark contrast, politeness' relations with ability constructs were mostly negative and smaller in magnitude. Politeness correlated **–.12** (95% CI [–.14, –.11]) and **–.16** (95% CI [–.18, –.13]) with fluid abilities of induction and quantitative reasoning. For acquired knowledge constructs, the relations were negative and of similar magnitude (mean $\widehat{\rho}$ = **–.16**, mean 95% CI [–.17, –.15]). Politeness-related traits may require effortful inhibition of behavior to avoid rude, manipulative, and belligerent behavior, reducing cognitive resources available for cognition and producing negative correlations with most cognitive abilities. Negative relations with acquired cognitive abilities may similarly result from psychological resources being directed to investment in social graces rather than knowledge accumulation in other domains.

The compound personality traits most related to agreeableness include warmth, interpersonal sensitivity, customer service, trust, machiavellianism,[‖] and self monitoring (27). These traits had negligible relations with cognitive abilities in most cases but there were a few noteworthy trends. Intriguingly, positive relations were found for interpersonal sensitivity (empathy) and general mental ability ($\widehat{\rho}$ = **.20**, 95% CI [.13, .27]) as well as machiavellianism with fluid abilities (mean $\widehat{\rho}$ = **.18**, mean 95% CI [.13, .22]), visual processing abilities (mean $\widehat{\rho}$ = **.12**, mean 95% CI [.10, .13]), and acquired knowledge abilities (mean $\widehat{\rho}$ = **.19**, mean 95% CI [.18, .21]).

Conscientiousness Traits. Conscientiousness-related traits involve self-discipline and organization (42). Conscientiousness' aspects are industriousness and orderliness, and its major facets are achievement, cautiousness, dependability, order, persistence, and procrastination avoidance (27). The results for conscientiousness

[#]Self esteem indexes self-confidence, self-assurance, and self-worth. Stress tolerance is the tendency to handle pressure well and without anxiety, even in difficult conditions. Internal locus of control is a tendency to believe that one has control over what happens to oneself (27).

[‖]Machiavellianism is related to the low pole of agreeableness. Machiavellianism is the tendency to disregard social norms and use deceit to achieve personal gain. Interpersonal sensitivity is the tendency to be tactful in social situations and sensitive to others' moods (27).

Fig. 2. Meta-analytic relations of agreeableness- and conscientiousness-related traits with cognitive abilities. *Note.* See Fig. 1 Note. Legend and dendrogram from Fig. 1 not shown due to space considerations.

constructs are fully detailed in *SI Appendix*, Tables S31–S46. Comparisons to previous meta-analyses (where available) are presented in *SI Appendix*, Table S86.

Conscientiousness traits tended to correlate positively with cognitive abilities. Global conscientiousness' relations were weaker and less consistent than its aspects and facets (see Fig. 2; synthesized in Table 1).

Industriousness had uniformly positive, noteworthy relations with abilities. Industriousness reflects individual differences in being hard working, resourceful, and competent (27, 43). It was one of the stronger personality correlates of general mental ability ($\widehat{\rho}$ = **.32**, 95% CI [.31, .34]). Smaller but still positive relations were found with primary and specific abilities including associational fluency ($\widehat{\rho}$ = **.14**, 95% CI [.09, .20]), originality and creativity ($\widehat{\rho}$ = **.26**, 95% CI [.25, .27]), short term memory abilities (mean $\widehat{\rho}$ = **.11**, mean 95% CI [.09, .13]), and processing speed abilities (mean $\widehat{\rho}$ = **.18**, mean 95% CI [.17, .19]). Visual processing abilities were weakly related (mean $\widehat{\rho}$ = **.07**, mean 95% CI [.01, .13]). Most relations with acquired knowledge abilities were in excess of .25.[**] Industriousness may be a useful trait for guiding the investment of non-invested abilities into knowledge acquisition.

Facets of industriousness had weaker relations. Surprisingly, this included very small relations across abilities for achievement and persistence (mean $\widehat{\rho}$ = **.05**, mean 95% CI [–.01, .11]). Dependability represents tendencies to be responsible and dutiful (27). Dependability's pattern of relations was more like industriousness though weaker (mean $\widehat{\rho}$ = **.11**, mean 95% CI [.04, .19], with acquired knowledge relations potentially stronger: mean $\widehat{\rho}$ = **.19**, mean 95% CI [.11, .28]).

Relations with the orderliness aspect were also variegated. Orderliness represents general tendencies toward precision, organization, and neatness (27). Orderliness and its order facet may

[**]Mean $\widehat{\rho}$ = **.30** with verbal abilities (mean 95% CI [.28, .33]), mean $\widehat{\rho}$ = **.30** with quantitative abilities (mean 95% CI [.22, .39]), and mean $\widehat{\rho}$ = **.21** with domain specific abilities (mean 95% CI [.18, .23]).

Fig. 3. Meta-analytic relations of extraversion-related traits, openness-related traits, and factor beta with cognitive abilities. *Note.* See Fig. 1 Note. Legend and dendrogram from Fig. 1 not shown due to space considerations.

represent failure to self-regulate focus toward high-priority goals (e.g., compulsion may drive a person to clean their desk before working on a more important task). Alternatively, higher ability individuals may not need the structure added by orderliness-related traits to self-regulate toward goals, as suggested by the compensation hypothesis (44). Consistent with these characterizations, meta-analyses for the orderliness aspect and order facet displayed mostly negligible relations with most non-invested abilities (mean $\widehat{\rho}$ = **.03**, mean 95% CI [−.01, .07]).[††] However, orderliness and order had small-to-medium, positive relations with processing speed abilities (mean $\widehat{\rho}$ = **.13**, mean 95% CI [.11, .16]) and verbal abilities (mean $\widehat{\rho}$ = **.13**, mean 95% CI [.10, .17]). More organized individuals may acquire more knowledge based on their perceptual speed as well as the unique, non-ability behavioral advantages associated with order (e.g., organizing one's materials).

Among conscientiousness facets, cautiousness stood out as a negative correlate. It had small, but near-uniform, negative correlations with 19 acquired knowledge abilities (mean $\widehat{\rho}$ = **−.10**, mean 95% CI [−.10, −.09]), suggesting that individual differences in cautiousness are associated with slightly lower levels of learning in most knowledge domains.

The compound personality traits most related to conscientiousness include routine seeking, cold efficiency, judging–perceiving, self-control, type A, achievement via independence, and rugged individualism.[‡‡] Routine seeking was a distinctively negative correlate of cognitive abilities across the spectrum, especially acquired knowledge (mean $\widehat{\rho}$ = **−.28**, mean 95% CI [−.35, −.22]). Echoing findings for industriousness, achievement via independence was a strong, positive correlate of several cognitive abilities (mean $\widehat{\rho}$ = **.31**, mean 95% CI [.22, .40]) especially general mental ability ($\widehat{\rho}$ = **.37,** 95% CI [.31,

[††]**−.08** with fluid abilities (mean 95% CI [−.11, −.05]), **.04** with long term memory's retrieval fluency abilities (mean 95% CI [−.01, .10]), and **−.01** with visual processing abilities (mean 95% CI [−.05, .03]).

[‡‡]Routine seeking is the predisposition toward predictable patterns of thought and behavior. Achievement via independence is the tendency to be driven to achieve goals in unstructured situations. Rugged individualism represents the tendency to be competitive, adventurous, bold, and independent (27).

Table 1. Means of meta-analytic personality–ability relations

	General mental ability	Non-invested abilities	Fluid abilities	Memory abilities	Long term storage and retrieval abilities	Learning efficiency abilities	Retrieval fluency abilities	Short term memory abilities	Visual processing abilities	Processing speed abilities	Invested/ acquired abilities	Quantitative abilities	Verbal abilities	Domain specific knowledge abilities	Mean across all abilities
Neuroticism	−.08	−.08	−.09	−.06	−.06	−.06	−.06	−.06	−.09	−.11	−.07	−.05	−.09	*−.06*	−.07
Withdrawal	−.15	−.12	−.15	−.12	−.13	−.16	−.13	−.13	*−.03*	*−.04*	−.10		−.15	−.06	−.11
Volatility	−.06	−.09	−.12	−.07	−.07	−.09	−.08	−.07		−.06	*.03*		*.02*	.07	*−.06*
Negative affect	−.16	−.09	−.13	−.08	*−.07*	−.10	*−.04*	−.09			−.27		−.27		−.13
Depression	−.18	−.13	−.16	−.11	−.10	−.06	−.12	−.19	−.18	−.09	−.17		−.18	−.10	−.14
Anxiety	−.07	−.04	−.07	*−.02*	*−.01*	.07	−.07	−.07	−.09	*.01*	−.12	−.12	−.14	−.07	−.07
Anxiety (test)	−.20	−.17	−.26	*−.08*	*−.11*		*−.11*	*−.06*			−.23	−.20	−.24	−.23	−.21
Uneven tempered	−.29	−.08	−.05	−.09	−.08	*−.05*	−.09	−.11	−.05	−.17	−.23	−.25	−.28	−.18	−.15
Suspiciousness	−.17	−.16	−.15	−.18	−.13	−.23	*−.08*	−.25	−.11	−.14	−.22		−.22		−.19
cd.-Self esteem	.25	.11	.11	.12	.12	.09	.13	.11	.10	.08	.21	.23	.22	.20	.15
cd.-Stress tolerance	.08	.13	.10						.12	.15	.14	−.07	.16	.19	.14
cd.-Locus of control	.23	.12	.18	.10	.10	.08	.10	.12	.09	.13	.29	.38	.30	.23	.15
Agreeableness	−.01	*.02*	−.04	.04	.05	.07	*.04*	*.01*	*.01*	*.00*	*.00*	*−.03*	*.02*	*.00*	*.01*
Compassion	.26	.07	*.01*	.07	*.05*	.08	.04	.12	.03	.14	.24	.18	.30	.19	.15
Politeness	*.00*	*−.02*	−.14	*.01*	*.01*	*.03*	*.02*	*.01*	−.05	.04	−.16	−.16	−.13	−.18	−.06
Tender mindedness	−.05	*−.03*	−.07	*.05*				*.05*	*−.04*	*.01*	*−.06*		*−.06*		*−.03*
Nurturance	*.02*	*−.02*	−.05	*.04*				*.04*	*−.03*	*.02*	−.09	−.16	*.02*	−.16	−.04
Cooperation	*.00*	*.04*	*.00*	*.01*				*.01*	*.01*	.11	*.02*	−.08	.07	*.00*	*.03*
Lack of aggression	*.00*	*.04*	*−.01*	*.06*				*.06*	*.04*	.10	.08		.08		*.06*
Modesty	−.13	−.08	*−.03*	−.11	−.17		−.17	−.09	−.12	*−.06*	−.11		−.11		−.08
Non manipulative	*−.02*	*.03*	.07	*−.02*	−.09		−.09	.08	*.04*	*.02*	*.05*	*.03*	.09	*.01*	*.03*
cd.-Warmth	*.01*	*.02*	−.06	.10	.11	.17	.10	.08	−.07	.07	−.07	−.12	*−.05*	−.07	*−.02*
cd.-Interpersonal sensitivity	.20	*.05*	*.04*						*.05*		.05		.05		*.06*
cd.-Customer service	*.10*	*.04*	.09	−.05				−.05		*−.01*	*.01*	−.08	*.05*	*.03*	*.03*
cd.-Trust	.09	.06	.10	.08	*.02*		*.02*	.14	*.04*	*.03*	.06	*.02*	.10	*.03*	.06
cd.-Machiavellian-ism	*.01*	.14	.18						.12	.05	.19	.23	.10	.22	.15
cd.-Self monitoring	.12	.07	.07												.10
Conscientiousness	*.01*	*.02*	−.08	*.03*	*.02*	*.03*	*.02*	*.04*	*.00*	.09	*.00*	−.07	*−.01*	*.05*	*.01*
Industriousness	.32	.09	*.01*	.10	.10	*.06*	.13	.11	.07	.18	.25	.30	.30	.21	.17
Orderliness	−.06	*.01*	−.08	.06	.06	.12	.06	*.05*	−.05	.09	*−.01*	−.09	*.01*	*−.02*	*−.01*
Achievement	.04	*.05*	*.02*	*.08*	*.08*	.21	*−.01*	.08	.04	.05	*.02*	*.01*	*.04*	−.11	*.04*
Persistence	.04	.07	*.03*	*.06*	*.08*		*.08*	*.03*	.11	.10	*.03*		*.03*		*.06*
Dependability	.16	*.07*	*.00*	.09	*.08*	.17	*.08*	.12	.09	.07	.19	.19	.16	.24	.11
Cautiousness	−.08	*−.01*	*−.04*	*−.01*	*−.01*	.08	*−.05*	*−.01*	*.01*	−.02	−.10	−.07	−.09	−.12	−.05
Order	.17	.05	−.09	.05	*.04*	.11	*.02*	.09	.11	.16	.17	.13	.24	.13	.11
Procrastination avoidance	*−.05*	.07	.07								.13	.22	.09		.08
cd.-Routine seeking	−.13	−.16	−.18	−.16	−.16	−.16			−.15	−.14	−.28	−.28	−.22	−.35	−.20
cd.-Cold efficiency		*−.01*	.09	*−.07*	*−.07*		*−.07*		−.08						*−.01*
cd.-Judging–perceiving	−.11	−.12	−.14	−.12	−.12		−.12		*−.09*		*−.04*		*−.04*		*−.09*
cd.-Self control	*.01*	*.02*	*.00*	*.04*				*.04*	*.01*	.07	*.04*	*.02*	*−.03*	.09	*.01*
cd.-Type A	*.03*	*.01*	*−.03*						*.02*		*.04*			*.04*	*.03*
cd.-Achievement via indep*	.37	.18	.17						.26	.13	.37	.41	.25	.58	.31
cd.-Rugged individualism	.11	*.07*	.08	.10	.11		.11	*.08*	.10	*−.03*	.16	.26	.13	.16	.11
Extraversion	−.02	*.03*	*−.01*	.06	.07	*.03*	.11	*.01*	*−.01*	.03	*−.02*	−.09	*.02*	*−.04*	*.01*
Enthusiasm	.11	.14	.08	.16	.14	.19	.14	.15	.10	.17	.13		.12	.17	.13
Assertiveness	*−.03*	.07	−.02	.10	.10	.12	.13	.10							.06
Dominance	.11	.06	.04	.09	.12		.12	.06	.04	.05	.09	.13	.10	.06	.06
Activity	.23	.10	.06	.10	.11	*.04*	.15	.08	.10	.14	.21	.20	.22	.21	.14
Positive emotionality	*.04*	.09	*.03*	.11	.11	.15	.12	.09	.10	.08	*.03*		*.03*		.07
Sociability	.10	.04	−.05	.09	.12		.12	.05	*−.03*	.16	.10	.05	.17	.06	.07
Sensation seeking	.06	*.02*	*.01*	*.02*	*.03*	*−.03*	*.06*	*.00*	*.02*	*.02*	*.07*	*.02*	.08	*.07*	*.04*
cd.-Optimism	.13	.09	.05	.13	.14	.16	.16	.14	*.02*	*.00*	.11	.25	*.05*	.22	.10
cd.-Ambition	.06	.10	*−.01*						*−.03*	.45	.14	.19	.19	.09	.11
cd.-Ambitious risk taking															

Table 1. (Continued)

	General mental ability	Non-invested abilities	Fluid abilities	Memory abilities	Long term storage and retrieval abilities	Learning efficiency abilities	Retrieval fluency abilities	Short term memory abilities	Visual processing abilities	Processing speed abilities	Invested/ acquired abilities	Quantitative abilities	Verbal abilities	Domain specific knowledge abilities	Mean across all abilities
cd.-Risk taking	*.03*	.06	.06												.05
cd.-Managerial potential	.27	.07	.07								.10		.10		.14
cd.-Grandiosity and iIntimidation	−.11	.02	.02						.04	−.02	.05	.06	−.01	.09	.03
cd.-Narcissism	*.03*	*−.04*	*−.02*						*−.05*		−.05		−.05		*−.02*
cd.-Restrained expression	*.04*	*.07*	*.07*								.17		.10	.30	.11
Openness	.26	.14	.19	.16	.16	.13	.22	.14	.10	.08	.20	.07	.29	.18	.16
Experiencing	.22	*.05*	*−.01*	.08	*.06*	*−.06*	.10	.17	*−.04*	.17	.17	.17	.28	.09	.10
Intellect	.26	.14	.17	.13	*.12*	.22	*.11*	.21	.12		.17	.16	.21	.12	.15
Need for cognition	.28	.16	.21	.14	.12	.22	*.02*	.17		.13	.28		.28		.21
Ideas	.40	.20	.18	.19	.17	*−.01*	.25	.22	.26	.19	.39	.30	.38	.46	.28
Curiosity	.17	.14	.18						.12	.08	.26	.20	.25	.30	.19
Introspection	.19	.04	.06	.11	.11		.11		*.01*	−.08	.22	.21	.17	.24	.12
Fantasy	.08	.08	.08	.09	.10	*−.04*	.16	.08	.12	*.01*	.13		.13		.09
Esthetics	.06	*.02*	*−.03*	.09	.09	*−.02*	.15	.09	*−.01*	*−.01*	*.00*	−.14	.15	−.15	*.01*
Non traditional	.19	.11	.19	*.09*	*.12*	*.09*	.12	*.02*	.11	.10	.24		.24		.12
Variety seeking	.04	*.08*	*.04*	*.09*	*.09*	*−.02*	.15	.09	.12	.10	*.01*		*.02*	*−.04*	*.06*
cd.-Openness to emotions	*.06*	.12	*.06*	.14	.16	*.02*	.23	.11	*.11*	.12	.16		.16		.11
cd.-Tolerance	.22	*.01*	*−.05*						.27		.37	.34	.32	.44	.20
cd.-Innovation	.08	.09	.07						.14	.06	.08	.01	.13	.10	.09
cd.-Creative personality	.25	.19	.18						.21		.32		.32		.24
cd.-Indep of cnvtns, others*	.13	.08	.08								.14	.14	.13		.11
cd.-Resourcefulness	*.01*	.23	.25	.23	.23	.23			.10	.28	.35		.35		.21
General factor of personality	.36	*.02*	*.02*								*.00*	*.01*	*.00*	*−.01*	*.05*
Factor alpha	.09	.07	.06	.09	.09	.13	*.06*	.12	*.01*	.13	*.07*	.26	*.05*	*.01*	.06
Factor beta	.20	*.06*	.10	*.07*	*.05*	*−.04*	*.09*	.14	*.02*	*.05*	.22	.32	.25	.19	.13

Note. Values are means of meta-analytic relations based on at least 10 effect sizes or 1,000 participants for abilities' clusters in the column headings. General mental ability relations are the meta-analytic estimates themselves. Auditory processing, reaction and decision speed, psychomotor ability, and psychomotor speed are not shown since they were not explicitly searched for in these meta-analyses. "cd." denotes compound traits. * Abbreviated form of Achievement via independence and, in second instance, Independent of conventions and others. Italics indicate where means of 95% CIs included zero. Empty cells had no meta-analytic relations based on at least 10 effect sizes or 1,000 participants. See *SI Appendix*, Table S89 for associated mean 95% CIs of mean relations presented. Mean correlations presented in this table summarize findings depicted in Figs. 1–3; full details of contributing meta-analyses may be found in *SI Appendix*, Tables S4–S82.

.43]), non-invested abilities (mean $\hat{\rho}$ = **.18**, mean 95% CI [.11, .26]), and acquired knowledge (mean $\hat{\rho}$ = **.37**, mean 95% CI [.27, .47]). To a lesser degree, rugged individualism was positively correlated with several cognitive abilities, in particular acquired knowledge (mean $\hat{\rho}$ = **.16**, mean 95% CI [.06, .25]).

Extraversion Traits. Extraversion-related traits reflect behavioral engagement with the external world and sensitivity to rewards. Extraversion's aspects are assertiveness and enthusiasm, and its major facets are activity, dominance, positive emotionality, sensation seeking, and sociability (45). Extraversion is aligned to dopaminergic systems associated with arousal, behavioral activation, ambition, and influencing (45–47). In contrast to previous meta-analyses that reported mostly null effects for extraversion–abilities relations (17, 18), our larger dataset and more nuanced construct structures revealed previously unacknowledged relations. The results for extraversion constructs are fully detailed in *SI Appendix*, Tables S47–S62. Comparisons to previous meta-analyses (where available) are presented in *SI Appendix*, Table S87.

Generally, global extraversion is *negligibly* related to cognitive abilities though sporadic, modest, positive relations with retrieval fluency abilities were detected along with modest, negative relations with some quantitatively oriented acquired knowledge abilities (see Fig. 3; synthesized in Table 1).

Extraversion's activity facet had sizable, positive relations with cognitive abilities. It correlated **.23** with general mental ability (95% CI [.22, .24]). Its relations were also positive but weaker with retrieval fluency abilities (mean $\hat{\rho}$ = **.15**, mean 95% CI [.10, .20]) as well as processing speed abilities (mean $\hat{\rho}$ = **.14**, mean 95% CI [.14, .15]). It was also a medium, positive correlate of acquired knowledge abilities, having near-uniform, positive correlations with all acquired knowledge constructs examined (mean $\hat{\rho}$ = **.21**, SD of $\hat{\rho}$s = .03, mean 95% CI [.21, .22]). It appears that individuals who are energetic and active score higher on knowledge measures, regardless of the area. This may partially be due to activity's correlation with speed of stimuli processing and retrieving information from long term memory. The high activity, processing ability, and long term memory trait cluster may correspond to a high-performance/energy setting for individuals (48).

The related traits of assertiveness and dominance had modest, positive correlations with long term memory's retrieval fluency abilities (mean $\hat{\rho}$ = **.12**, mean 95% CI [.07, .18]). Dominance had small, positive relations with general mental ability ($\hat{\rho}$ = **.11**, 95% CI [.10, .12]), as well as several acquired knowledge abilities, most notably quantitative (mean $\hat{\rho}$ = **.13**, mean 95% CI [.10, .17]) and verbal abilities (mean $\hat{\rho}$ = **.10**, mean 95% CI [.10, .11]).

Extraversion's enthusiasm aspect and associated facets (i.e., positive emotionality and sociability) had sporadic relations with cognitive abilities ($\hat{\rho}$ range = −**.22** to **.29**). Notably, sociability had

a small, *negative* relation with quantitative reasoning ($\hat{\rho}$ = **–.13**, 95% CI [–.15, –.11]) and small-to-medium, *positive* relations with verbal abilities (mean $\hat{\rho}$ = **.17**, mean 95% CI [.16, .19]). The sensation seeking facet of extraversion was also a small, positive correlate of comprehension knowledge abilities (mean $\hat{\rho}$ = **.12**, mean 95% CI [.08, .16]).

Compound personality traits related to extraversion include optimism, ambition, ambitious risk taking, risk taking, managerial potential, grandiosity and intimidation, narcissism, and restrained expression.[§§] Among these, optimism, ambition, and managerial potential stood out. Optimism had small-to-medium, positive correlations with several cognitive abilities (mean $\hat{\rho}$ = **.10**, mean 95% CI [.05, .15]). Ambition was a positive correlate of many acquired knowledge constructs (mean $\hat{\rho}$ = **.14**, mean 95% CI [.06, .23]) as well as some processing speed abilities (mean $\hat{\rho}$ = **.45**, mean 95% CI [.37, .53]), though their magnitudes varied (SD of their $\hat{\rho}$s = .10 and .29, respectively). Managerial potential[¶¶] was positively associated with general mental ability ($\hat{\rho}$ = **.27**, 95% CI [.20, .33]).

Openness Traits. Openness-related traits involve cognitive exploration and stimulation. Openness' aspects are experiencing and intellect, and its major facets are esthetics, curiosity, fantasy, ideas, introspection, need for cognition, non traditional, and variety seeking (49). The results for openness constructs are fully detailed in *SI Appendix*, Tables S63–S79. Comparisons to previous meta-analyses (where available) are presented in *SI Appendix*, Table S88.

Openness-related traits are widely acknowledged correlates of cognitive abilities (17). This study's meta-analytic investigations replicated this finding (e.g., global openness and general mental ability correlated **.26**, 95% CI [.25, .27]; see Fig. 3 which is synthesized in Table 1).

Mean associations between openness and non-invested abilities were smaller: **.19** with fluid abilities (mean 95% CI [.16, .22]), **.16** with long term storage and retrieval (mean 95% CI [.10, .22]), **.14** with short term memory abilities (mean 95% CI [.10, .17]), and **.10** with visual processing abilities (mean 95% CI [.07, .14]). Within invested abilities, openness' relations with verbal abilities (mean $\hat{\rho}$ = **.29**, mean 95% CI [.21, .37]) were much stronger than that with quantitative abilities (mean $\hat{\rho}$ = **.07**, mean 95% CI [.00, .13]). Other verbally oriented, domain specific knowledge constructs correlated similar to verbal abilities (i.e., foreign language proficiency, behavioral content knowledge, general science knowledge, social studies knowledge, arts and humanities knowledge; mean $\hat{\rho}$ = **.25**, mean 95% CI [.12, .38]). These results highlight differential relations across invested versus non-invested abilities but also further distinctions within those categories.

A key finding was the distinctive patterns of results for the intellect versus experiencing aspects, supporting previous research (50). Intellect, need for cognition, curiosity, and ideas were positive correlates of cognitive abilities and mostly tracked each other within limits of sampling error. Overall, these intellect-related traits' relations were in line with previous meta-analytic estimates (17, 19) (mean $\hat{\rho}$ = **.21**, mean 95% CI [.13, .29]), with many in the medium-to-large range (e.g., general mental ability: mean $\hat{\rho}$ = **.28**, mean 95% CI [.22, .33]). The results were similar among the subcomponents: need for cognition ($\hat{\rho}$ = **.21**, 95% CI [.14, .27]) and other intellect facets of ideas and curiosity (mean $\hat{\rho}$ = **.25**, mean 95% CI [.17, .32]). In general, intellect traits had sizable, positive relations with verbal and quantitative abilities. Verbal abilities correlated **.30** on average (mean 95% CI [.21, .39]), though meta-analytic relations varied (SD of $\hat{\rho}$s = .09). Acquired quantitative abilities correlated **.22** on average (mean 95% CI [.12, .32]).

The experiencing aspect of openness and its fantasy and esthetics facets were negligibly related to most non-invested abilities (mean $\hat{\rho}$ = **.05**, mean 95% CI [–.01, .10]). Relations were .01 with fluid abilities (mean 95% CI [–.04, .06]), .00 with visual processing abilities (mean 95% CI [–.05, .04]), .08 with processing speed abilities (mean 95% CI [.05, .12]), and .09 with memory constructs (mean 95% CI [.02, .16]).

Retrieval abilities demonstrated consistently modest, positive relations with these experiencing traits (mean $\hat{\rho}$ = **.12**, mean 95% CI [.06, .18]). Most importantly, they correlated differentially with acquired abilities: on average **.23** with acquired verbal abilities (mean 95% CI [.20, .26]) but only **.09** with acquired quantitative abilities (mean 95% CI [.08, .11]).

Higher Order Personality Traits. In the hierarchy of personality traits, two meta-traits (factors alpha and beta) are above the Big Five. In self-report, but not observer-based, personality measures, studies have also reported a general factor of personality (27, 51) (see *SI Appendix*, Fig. S1 for depiction).

Factor alpha, also referred to as stability/socialization, is a higher order meta-trait that captures the shared variance of emotional stability, agreeableness, and conscientiousness. Individuals with high levels of factor alpha tend to function well in human society and those with low levels often have antisocial tendencies (27). Relations between factor alpha (stability/socialization) and cognitive abilities were much smaller in magnitude than the relations with several of the neuroticism- and conscientiousness-related personality traits (see Fig. 1; synthesized in Table 1). The results for higher order personality traits are fully detailed in *SI Appendix*, Tables S80–S82. Comparisons to previous meta-analyses (where available) are presented in *SI Appendix*, Tables S84 and S87.

Factor beta, also referred to as plasticity, is a higher order meta-trait that captures the shared variance of extraversion and openness. Individuals with high levels of factor beta tend to explore the world cognitively and perceptually (52). Factor beta tended to be positively related to cognitive ability constructs but to a lesser degree than the intellect aspect and related facets of openness (see Fig. 3; synthesized in Table 1). Plasticity appears to be a relevant personality trait for knowledge acquisition (mean $\hat{\rho}$ = **.22**, mean 95% CI [.13, .32]).

The general factor of personality is controversial. Many view it as an artifact of self-reporting (53, 54). Others note its substantial overlap with self-report trait measures of emotional intelligence and suggest that it reflects social effectiveness (55). Yet others find it to be partly a stable self-evaluative trait and partly a set of inventory-specific response tendencies (51, 56). We report the results of analyses for the general factor of personality in the tables and figures for completeness (Fig. 1 and Table 1). In *SI Appendix*, *Supplementary Text, Meaning of the general factor of personality*, p. 11, we provide more information about this factor to facilitate correct inferences and interpretations.

Discussion

Personality and cognitive ability are vast, consequential domains of differences among individuals. Our meta-analyses surveyed personality–ability relations across a century of research, hundreds of constructs, and millions of people. The findings quantify and catalog differential relations based on hierarchical construct levels. Connections between the domains extend beyond openness-related traits. The results discern previously unrecognized, psychologically meaningful trait linkages as well as areas where further research is needed.

[§§] Restrained expression is associated with *low* extraversion (27).

[¶¶] Managerial potential is described as the tendency to provide fair, stable leadership (27).

Strengths and Weaknesses. Others have examined some of these relations using primary studies as well as meta-analyses, but the present work is set apart by the a) scale of its database; b) breadth, depth, and empirical grounding of the personality and ability taxonomies used; and c) extent of new relations meta-analytically quantified. These strengths afford insights relevant to scholars and practitioners across fields.

The current investigation's expansive database contained more than twelve times as many participants and seven times as many contributing samples as the largest previous meta-analyses of personality and cognitive ability (21). The database that we have assembled and are making available offers a firm foundation for future research.

The current results are reported at a more granular level than previous works due to advances in taxonomic knowledge of personality and cognitive ability (43, 49, 52, 57–62). Using comprehensive, evidence-based taxonomies enabled 1) the investigation of more constructs than all previous meta-analyses combined, and 2) documentation of novel, theoretically meaningful patterns in the results. Only 233 of the 3,543 relations examined were directly comparable to previously published meta-analyses. Nearly half of these comparable effect sizes shifted by .10 or more correlational points; in 22% of comparisons (52 analyses) the change was .15 correlational points or more (*SI Appendix*, Tables S84–S88 fully report these differences). Many of the conclusions drawn from previous meta-analyses merited revision based on the current results. More importantly, this research brought to light hundreds of previously unknown, sizable ability–personality relations.

We acknowledge that our research has limitations. Although our database is large, for some cognitive ability–personality pairs, data were scant. These gaps limit our ability to draw inferences but also point to areas worthy of future research.

Another limitation is that we rely on cross-sectional correlations, precluding developmental or causal inferences. As data further accumulate, meta-analyses of longitudinal relations are recommended to investigate the development of personality–cognitive ability relations.

Implications of Findings. Many cognitive abilities are correlated with diverse personality traits. Therefore, measuring a given cognitive ability is likely to give some indication of a set of personality traits (e.g., scoring high on mathematical abilities tends to suggest higher standing on ideas facet of openness but lower standing on politeness and orderliness). The findings also have implications for theories. For example, theories of self-regulation should further integrate personality traits and cognitive abilities (see *SI Appendix*, *Supplementary Text*, *Examples of implications for self-regulation theories*, p. 11).

Correlated personality traits and cognitive abilities may have shared etiologies including genetic (63), neurobiological (64, 65), cultural (66, 67), educational (68), and other factors. The current relations can help researchers to examine shared etiological factors that may have been overlooked as researchers from diverse fields review and contemplate the personality–cognitive ability relations quantified here.

This research also informs estimates of the joint utility of personality and cognitive ability measurements in predicting important behaviors and outcomes. For example, even though the associations of personality and abilities with a variety of important life behaviors and outcomes are well known (1, 2), establishing the direction and degree of relation between personality and cognitive ability variables enables the estimation of the *incremental* usefulness of each. In *SI Appendix*, *Supplementary Text, Implications of identifying overlap and uniqueness of personality and ability variables*, p. 12, we provide a description of how meta-analytic estimates from this study can be used in estimating incremental validity and unique effects to stimulate future research. For instance, both cognitive ability and personality traits have been demonstrated to predict career success metrics, such as job performance (69). Using personality–cognitive ability relations reported here, it is now possible to forecast the unique contributions of each personality trait and cognitive ability in domains such as education, work, intrapersonal, and social, among others. For example, researchers can examine ability–behavior relations controlling for related personality attributes and vice versa. Research silos solely utilizing variables from either the personality or cognitive ability domain will benefit, as variables from the omitted domain are incorporated into studies. The results also offer numerous insights that specialists could use to better predict and understand behaviors and outcomes in their own fields.

In conclusion, both personality traits and cognitive abilities contribute to stability, performance, and development in many life domains. Personality traits reflect different strategies for sensing, evaluating, and behaving. Cognitive abilities explain how efficiently and proficiently goals are set, pursued, and achieved in complex environments. Related personality traits and abilities likely coordinate the use of finite resources toward goal achievement as well as the generation of new goals, interpretations, and strategies as goals are attained or obstructed. This paper highlights important connections between these two fundamental domains of individual differences by providing the most comprehensive empirical catalog of cognitive ability–personality relations. These extensive findings deepen understanding of human psychological differences and pave the way for improved theoretical explanations of human behavior and applications that harness individuals' potential and improve the human condition.

Materials and Methods

Study Design. This research quantified personality–cognitive ability relations from a century of research and 2,010,980 people. Psychometric meta-analyses estimated relations between 3,543 ability–personality trait pairs.

Database. Nine systematic search procedures were followed to identify published and unpublished research (see *SI Appendix*, Fig. S5 PRISMA (70) diagram). The *SI Appendix, Supplementary Text, Study Identification* section provides complete details (p. 5). Identified studies represented people across demographics and included diverse scales. Electronic databases were queried with personality and ability keywords. Queries were run in English, German, Spanish, and Chinese to cover the countries with the most scientific psychology output in the world (71) as well as the most speakers in the world (72). The same keywords were searched in dissertation/thesis catalogs as well as databases specific to Africa, Europe, Latin America, Scandinavia, and 24 specific countries. We also examined eight "open" databases. Military data were obtained from multiple countries. High-relevance journals and conference programs were manually searched. Seven professional organizations sent contribution invitations to their members. Materials were examined page by page from several personal and organizational archives. We also manually retrieved 25 datasets from research archives and directories of professionally run studies (e.g., ref. 73). For all obtained materials, the reference lists were examined for citations of materials with relevant data/statistics.

Between-person, individual-level, observed, bivariate relations had to be reported or calculable. Studies with children younger than 12, psychiatric patients, ipsative measures, and experiments with manipulations that may have impacted personality or cognitive ability scores were excluded along with contrasted/extreme group studies. Detailed inclusion/exclusion criteria are provided with justifications in *SI Appendix*, *Supplementary Text*, *Inclusion and exclusion criteria*, p. 7.

Final set of Studies Included and Publication Bias Considerations. A total of 1,325 studies contributed independent data, including many beyond Western,

industrialized, rich, educated, and democratic societies (74). Despite more than 5 y of searching, our database is unlikely to be exhaustive, but we hope it includes a representative majority of the available, quantitative information on the relations between personality traits and cognitive abilities. Comparing the number of studies with prior meta-analyses indicates that the current database is the largest and most comprehensive to date on ability–personality relations and one of the largest meta-analytic databases on any topic (cf. only larger set of meta-analyses we are aware of ref. 75). Our meta-analyses provide a comparative baseline for future investigations.

Several factors protected these meta-analyses against publication bias. First was the depth of the search strategies. Second and more importantly, many studies were not expressly focused on examining personality–ability relations. Instead, these variables were incidentally included in examinations of other phenomena (e.g., physical health), reducing the threat of underreporting of null relations. Third, and most importantly, 63% of correlations were from unpublished sources and raw data. Correlations were computed from these generously shared data. Their inclusion safeguards against publication bias and surfaces findings from otherwise ignored datasets. In our database, the mean difference between published and unpublished correlations was .00 (±.02 correlational points for each of the Big Five), reinforcing that publication bias is not a concern.

A full list of contributing studies is presented in *SI Appendix, Supplementary Text, References for Studies Included in the Meta-Analyses*, p. 28. Publicly sharing our landmark database (https://osf.io/ehz5u/) that catalogs ability–personality trait relations from the past 100 y is one of the major contributions of this study.

Data Preparation. Coding, data entry, and construct categorization are fully described in *SI Appendix, Supplementary Text, Coding of Studies and Data Entry and Construct Categorization*, p. 8–9. Data were entered by trained research assistants and checked by the first author. Personality and ability scales were classified into constructs by the authors using published taxonomies and compendia (27). Each meta-analysis contains only independent effect sizes. When one sample would have contributed two effect sizes to the same meta-analytic estimate, a composite was formed to ensure that all available information was incorporated (76).

Statistical Analysis: Meta-Analytic Approach. Psychometric meta-analysis (76) was used to combine effect sizes across studies. The technique originated in applied psychology (77) but has now become ubiquitous. Psychometric meta-analysis is a random effects approach to cumulate findings across studies that minimizes the influence of sampling error while also accounting for differences across studies in reliability of measures and other statistical artifacts.

The mean observed correlation ($\bar{r}$) indicates the average, sample-size-weighted observed correlation across studies' effect sizes. In psychometric meta-analysis, $\bar{r}$ is corrected for unreliability as well as other applicable statistical artifacts (e.g., dichotomization) to obtain the estimated mean corrected correlation $\hat{\rho}$ (estimated true-score correlation). Correlations were corrected for sampling error and unreliability in both ability and personality measures to estimate construct-level relations (see *SI Appendix, Supplementary Text, Artifact distributions: corrections for unreliability and range restriction in cognitive ability and personality measures*, p. 15). The results' tables report observed and psychometrically corrected relations (*SI Appendix*, Tables S4–S82).

SD, indicates the variation of observed correlations. Observed SDs are inflated by unreliability and other measurement artifacts. SD $\hat{\rho}$ is corrected for this inflation and indicates the degree of true variability across studies.

Credibility intervals are computed using SD $\hat{\rho}$ and provide the likely range of population correlations or effect sizes (76). When SD $\hat{\rho} = 0$, the credibility interval has a width of zero. We also report 95% CIs, which indicate the precision of each meta-analytic effect size estimate. That is, 95% CI designates the 95% lower and upper confidence bounds associated with the mean meta-analytic estimate. Trends in the results were quantitatively synthesized across related meta-analyses using unit-weighted second-order meta-analytic techniques after excluding sampling-error-prone meta-analytic results (i.e., $N < 1{,}000$ and $K < 10$).

The psychmeta package in R (78) was used to estimate these various statistics and the script is provided (*SI Appendix, Supplementary Text, Data and Code Availability*, p. 10).

Locating Findings. *SI Appendix*, Tables S4–S82 detail complete results, including CIs. The results described above are based on findings less likely due to chance (i.e., meta-analyses with at least 10 independent contributing effect sizes or 1,000 participants). We also interpreted findings cautiously, mostly reporting central tendency trends across meta-analyses, rather than focusing on individual relations. Figs. 1–3 provide *all* estimated relations and indicate unstudied relations as well. Table 1 provides summary means of these meta-analytic relations. The magnitudes of the effects were not used to screen results.

Data, Materials, and Software Availability. Data (dataset) have been deposited in Open Science Framework (https://osf.io/ehz5u/) (79). All study data are included in the article and/or *SI Appendix*.

ACKNOWLEDGMENTS. This research would not have been possible without the contributions of thousands of studies, colleagues, and other researchers. These contributors are fully acknowledged in the *SI Appendix, Acknowledgment of Study Contributors*. We are especially grateful for Stephan Dilchert's sage advice in executing this research and preparing this manuscript.

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