Current Directions in Personality Science and the Potential for Advances through Computing

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Abstract—The past 20 years have seen dramatic advances in personality science, both in theory and methodology. Some of these advances reflect a natural but incremental conceptual evolution in a maturing science, but others can be attributed in part to the ever cheaper, more ubiquitous, powerful, and mobile computing. As a result, personality science in the 21st century is a fast-moving field poised to answer important questions across diverse areas, but it is also facing increasingly complex challenges related to assessing and summarizing the important features of human behavior. Computer science and engineering may hold the key to the next advances in personality science. In what is intended to serve as a complement to Vinciarelli and Mohammadi's *Survey on Personality Computing*, contemporary thinking and research in personality are summarized, the mounting importance of computing in personality research is highlighted, and an outline for future directions in personality computing is offered.

Index Terms—Personality, personality computing, assessment, personality perception, personality structure

1 Introduction

As a personality psychologist I read Vinciarelli and Mohammadi's *Survey on Personality Computing* with great interest. They highlight one of the main reasons for being interested in personality; namely, it is such a strong predictor of important life outcomes in relational, occupational, and social functioning [20], physical morbidity, mortality and longevity [3], [6], as well as major mental disorders [15], [25]. Given all of that, being able to reliably, validly, and efficiently assess personality is a worthwhile goal, and enlisting modern computer science has real potential for advancing that endeavor. At the heart of their survey, they provide a very clear summary of the personality computing literature and make a noble attempt to provide a scaffolding for organizing this area and moving forward with novel research. However, personality science is a rapidly changing field, and many of the notions they rely on as the foundation for their scaffolding have shifted, or are in the process of shifting dramatically. Included in this list is the basic structure of personality traits, perspectives on who possesses the knowledge of an individual's personality (i.e., self versus other ratings), and views on personality stability and the power of person-by-situation interactions. Several of the interesting directions in which personality research is heading can be attributed, in part, to advances in computational power and mobility. Moving forward, to achieve its full potential, personality and allied fields (e.g., clinical psychology) will likely need to draw on advances in data collection, integration, and analytic techniques that fall squarely in the domain of computer sciences. In what follows I summarize several contemporary foci of personality science as an update to Vinciarelli and Mohammadi's summary, and suggest some directions for greater personality and computer science integration.

2 The Structure of Personality

One of the undeniable achievements of psychological science in the 20th century was establishing a consensual structure of personality traits in the form of the Big-5.[1] As they emerge in the population at large, these traits are Extraversion, Agreeableness, Conscientiousness, Neuroticism, and Openness/Intellect. Yet, despite how robustly these five domains emerge and replicate across samples, raters, and measures, they are not the full story. Rather, personality traits appear to be organized hierarchically, ranging from many narrow-bandwidth constructs to broad meta-traits [7], [16]. That is to say, there are different levels of abstraction and fidelity at which personality can be conceived of and measured, with finer-grained domains being subsumed by more broad domains. Consider that behaviors like planning outings in advance, keeping one's room tidy, and having a system for filing receipts might all be understood aspects of Orderliness, which goes hand in hand (i.e., covaries between individuals) with Self-Discipline and Dutifulness. These bundle of narrow traits have shared and unique aspects, with the shared aspects being explained by Conscientiousness. Therefore, Conscientiousness, one of the major traits of the Big-5, is made up of several related but more circumscribed traits that each account for specific instantiations of behavior. In fact, each of the Big-5 can be understood to comprise several "facets," or closely related but narrower domains. The most widely used trait measure, the NEO-PI-R [5], has 6 facets per

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1. In the past some drew distinctions between the lexically derived Big-5 and the Costa & McCrae's (1992) Five-Factor Model. These days virtually all recognize that they are one and the same, and any distinctions are primarily of historical significance.

domain. For instance, NEO-PI-R Extraversion is comprised of Warmth, Gregariousness, Assertiveness, Activity, Excitement-Seeking, and Positive Emotions, and the other four domains are similarly diverse.

On the other end of the fidelity spectrum, readers may be surprised to know that in large samples Conscientiousness appears to covary with Agreeableness and Neuroticism, more so than Extraversion and Openness, giving rise to a "meta-trait" that has been termed "Alpha" or "Stability," and is hypothesized to related to central serotonergic functioning [7], [9]. Extraversion and Openness are also argued to share important variance and form a meta-trait termed "Beta" or "Plasticity," which is hypothesized to be driven by dopaminergic functioning [8].

So why does this matter? There are several reasons to think hierarchically about personality. For one, understanding the relationships among variables can clarify patterns of results. Being aware that Alpha or Plasticity emerges at the higher-order level of the structure clarifies certain types of repeated findings in the field, like the fact that Neuroticism, Agreeableness, and Conscientiousness each are the strongest predictors of morbidity and mortality in both physical and mental disorders. However, the mechanistic pathways for how each trait effects their outcomes may be different (e.g., Conscientiousness influences health behaviors; lack of Agreeableness leads to interpersonal conflict and lack of social support; etc.). Depending on the outcome of interest one wishes to predict, one may wish to target the broader meta-trait (e.g., to maximize general prognostic value) or the basic traits of the Big-5 (e.g., specific behavioral pathways).

Second, some aspects of personality are expressed more externally than others, and therefore are likely more amenable to third-party raters, computers included. Extraversion serves as a good example here, given that it is one of the most interpersonal of the traits, and the way it is defined and measured often emerges in overt behavior (e.g., talkativeness, smiling) even over short intervals. It was notable that in Vinciarelli and Mohammadi's survey the largest effect sizes across the summarized studies were consistently for Extraversion. However, within Extraversion there is a diversity of behavior that may be more or less difficult to measure; Gregariousness might be readily apparent, but Excitement Seeking may not emerge reliably in all situations depending on how it is assessed. One key point here is that specific tasks are likely to capture specific facets of a given domain, but not all tasks may be fungible for all features. Relatedly, using brief personality trait inventories that only capture narrow definitions of the traits could lead one to develop a computer task that does not generalize well.

Finally, despite being highly related, facets within a given domain sometimes have differential relationships to external constructs. For example, antisocial behavior, an outcome for which there is considerable societal interest in predicting, differs in its relationship to facets of the Neuroticism and Extraversion domains [23]. To the extent that a scale contains anger and hostility or impulsiveness it will correlate with antisocial behavior, but if it is mostly comprised of anxiety and depression items it will not. These types of findings are common and worth keeping in mind. Therefore, depending on the use for which a computer task or assessment is being designed, it is important to be precise about the level of the hierarchy one is interested in measuring and the inventory chosen to validate it. One need not have an encyclopedic knowledge of personality and its inventories to manage these tensions, just awareness and a little thoughtful consideration at the start of any study.

3 Self and Other Discrepancies in Personality Ratings

Building on the structure of personality, it is necessary to consider additional aspects of personality traits that influence their assessment. At various points in their summary, Vinciarelli and Mohammadi make reference to a "true" personality rating, suggesting that the individual's self-rating should serve as the gold-standard. Unfortunately, a "true" personality rating is now understood to be out of reach of any one rater (and possibly altogether). This is not to say there is no validity to a personality rating, regardless of who or what is making it, but rather that this question needs to be contextualized. There is no universal "true" personality rating, and instead the question becomes for what purpose? A very basic, but useful response to this question is to predict actual behavior (with behavior being defined broadly to include covert and overt aspects of functioning).

One should not be overly pessimistic about personality assessment. What is clear is that an individual's rating of their own traits does (a) provide important information about how they will behave, and (b) has moderate agreement with how others will rate them (see [28] for a review). Further, individuals appear capable of "meta-perception," that is, people are aware of the impressions they make on others. And, as noted above, self-ratings of personality predict many important life outcomes [20]. However, others ratings also increment, and sometimes outperform the self-ratings when predicting certain life outcomes (e.g., academic achievement, job performance, etc.; [4]. It is now quite clear that neither the self nor the other possesses all the necessary info for adequate personality ratings, and both can increment each other in predicting important outcomes. Rather than focus on the elusive "true personality," computer scientists interested in assessing personality and predicting important life outcomes based on it should consider whether the self or others should serve as the primary criterion in developing a task or a method.

In a seminal work, Funder [13] outlined features that will affect the accuracy of other ratings of traits, and, presumably, a computer's ability to perceive them as well. In the context of this commentary these features are worth highlighting. Funder's framework introduces the concepts of Relevance (i.e., the environment must allow the person to express the trait) and Availability (i.e., the trait must be perceptible to others). Relevance can be explained by the familiar experience of hearing from someone that only knew you in one context (e.g., work), "Wow, I never knew you had this side to you!" when you see them in another (e.g., a party). Thus, the general premise here is that if a particular trait is of interest it must be given the opportunity to express itself. Availability is best illustrated by contrasting an

externally expressed trait (e.g., talkativeness) with an internally expressed one (e.g., fantasy proneness); there may be some external markers of the latter (e.g., staring wistfully out the window), but in large part internal traits must rely on the self for reporting. Taking these in to consideration will likely sharpen the focus on the tasks necessary to elicit and perceive the traits of interest.

4 Personality as an Ensemble of Dynamic Processes in Context

Vinciarelli and Mohammadi's refer to personality as being, "at least to a certain extent, independent of the situation." This assertion alludes to one of the major 20th century debates in personality and social psychology: what matters more in predicting behavior, the person or the situation? A full summary of this debate goes beyond this commentary, but some social psychologists (e.g., [17]) went so far as to discount the contribution of the person all together (these arguments have since been withdrawn based on the accumulated evidence). In response, others argued for close to 100 percent consistency in behavior driven by individual differences. Arguing in absolutes may be good for rhetoric, but rarely is truth well served by the prospect. Science can benefit from absolute claims, however misguided they may be, and what has ultimately emerged from this debate is a recognition that personality's effects are often contextualized reflecting interesting interactions between the person and environment. Contemporary theories are moving beyond the illusory and fictive distinction between person and situation to understand patterns and processes of behavior as the individual navigates their environment. This is frequently termed "person-situation integration" or "person-x-situation interaction" in the personality literature. The view here is that personality may have certain main effects, but it is often contextualized behavior that we are interested in, such that individuals differ in how they respond to the same situation, but within individuals there is presumed to be stability in behavior across similar situations and variability across dissimilar situations. For instance, consider the socially dominant extrovert who is the life of any party, but is appropriately reserved in church. In contrast, a classically introverted person may be a wallflower at the same party, but quite vocal and assertive in the classroom. An entire issue of the *Journal of Research in Personality* was devoted to this in 2009 (Volume 43, Issue 2), and I would encourage interested readers to investigate some of the included articles.

In some respects, Vinciarelli and Mohammadi present a relatively balanced statement when then say, "at least to some extent" in reference the individual's contribution to behavior. However, I want to draw the reader's attention to this contemporary view of personality because I think it offers the most exciting prospects for the scientific integration of personality and computing. To briefly review, person-situation integration has been fueled by basic findings like the fact that trait relevant behavior varies just as much within people across moments and days as it does between people [10]. The mean level of behavior across successive periods (e.g., a week) is highly stable, but so is the level of variability [10], [18]. Thus, depending on how it is measured and aggregated, personality appears both highly stable and trait like, and also highly and variable and adaptive to context. One way of considering this is in terms of density distributions of behavior and functioning, such that each individual has a distribution of behavior within which they vary, with the mean of that distribution providing a classic notion of a trait [12]. This has lead to a call for recasting the Big-5 traits in terms of ensembles of related processes [11]. Other personality theories (e.g., Interpersonal Theory; [21]) have long had a process-based focus. I have argued that understanding dynamic processes will provide a much-needed bridge between models of adaptive and maladaptive functioning [29].

A major perpetuating factor of the person-situation debate was the fact that personality scientists lacked access to the types of instruments, methods, and analytic tools to appropriately test complex theories. In fact, much of the foundational literature on personality was decidedly process based (e.g., [1]). However, to truly understand dynamic processes they need to be measured as such, and quantitative methodologies are needed to model them as such. Through much of the last century this was impossible, with the major rate limiting steps being that (a) individuals could not economically be intensively and repeatedly measured in various settings, and (b) the necessary computational power and software that allows for the analysis of ever larger and complex datasets with demanding statistical techniques was neither cheap nor ubiquitously available. Both of these have changed. With the advent of palm-top computing, and now smart-phones, the ability to intensively and repeatedly measure individuals in their natural environment has exploded. This coupled with powerful but cheap computing power and increasing options for software has allowed personality science to finally make good on the promise of early theory.

Mobile computing is being put to good use in studies using intensive and repeated measurement in naturalistic settings (see [19]). Sometimes referred to as ecological momentary assessment or ambulatory assessment more generally, investigators are arming their participants with palm-top computers and now smart-phones that are able to capture incredible amounts of data in daily life as it is lived [26]. These data may come in the form of basic questionnaires administered multiple times per day, in response to specific events, captures of ambient noise, sensors of physiological functioning, and more. Novel insight in to how persons actually function is emerging. For instance, Beckmann et al. [2] showed that although the between-person correlation between Conscientiousness and Neuroticism is negative, the within-person (i.e., momentary) correlation among the two in managers is positive! They demonstrated that as managers experience more negative emotions at work (e.g., anxiety) they enact more conscientious behavior, presumably to manage crises as they arise. This type of finding is highly useful, and could be used as the basis for assessing and evaluating managers, and possibly in selection or performance improvement. I note that this is a within-person process that has between-person (i.e., individual differences) in its strength.

One of the strengths of ambulatory assessment is the high degree of ecological validity achieved when assessing

individuals in their natural environment. Nevertheless, sometimes more fine-grained processes are of interest, and these may be best sampled in more controlled environments that allow for data sampling many times per minute. Interesting and personality relevant work is being conducted examining interpersonal transactions sampled multiple times per second [24], automated recordings of body movement [22], and automated facial affect coding [14]. The readers of this journal will no doubt have many more examples of this sort at their fingertips, but these types of assessment procedures and techniques may not immediately come to mind if one thinks of personality as a static individual difference. I want to stress that considering dynamic processes at various levels of granularity is the vanguard of personality science.

5 The Role of Computer Science in the Future of Personality Science

Now that personality science has come of age and has demonstrated its utility in a very general way, the time has come to take personality science a step further through more refined and pluralistic data acquisition and modeling. Here is where computer scientists can step in and make a great contribution to both basic and applied personality science. As I noted above, advances in computing portability, power, and price have all had an undeniable influence on the field. What personality psychologists generally lack is good engineering and computational expertise in order to bring method in line with theory. I am confident that through increased intellectual commerce between personality and computer scientists, there is the potential for having a real impact in personality assessment and theory. At the same time, personality psychologists, who have in depth training in human behavior, could presumably help computer scientists refine their focus and provide a guide for their efforts.

An area that is particularly ripe for collaboration is in developing individualized models of personality that will be built ideographically from the bottom up. In other words, personalized models of functioning that would be highly articulated and based on data streams of many different types (e.g., self-report, physiological monitoring, passive ambiance capture, etc.). The goal would be to capture the whole individual in life as it is lived. This could then be used in an applied fashion in various contexts. For example, psychiatry, an allied discipline, has long struggled with a diagnostic system that lacks adequate validity, and practitioners are stuck trying to apply ill-fitting diagnoses to suffering individuals. To the extent that techniques for assessing dynamic behavioral processes could be applied in the clinical domain, clinicians could render a "precision diagnosis" that would improve intervention (see [27]). The challenge would be to make this automated, customizable, and user-friendly. A further hope would be that the pattern recognition capabilities for which computers are so famous could be leveraged to develop novel diagnostic schemes that improve our understanding of disorders and offer more valid constructs for studying etiology, development, and intervention.

6 Conclusion

In sum, I found Vinciarelli and Mohammadi's Survey on Personality Computing to be a very interesting read and admirable effort to bring together two traditionally disparate fields. There is much to gain from a close read of their paper. Nonetheless, I found that there were several additions, based on the state of personality science, to what they present that might augment its utility. Thus I briefly summarized the notion of a personality hierarchy, contemporary perspectives on self- versus other-ratings, and dynamic processes in personality. My own summary is in no doubt quite limited by ignorance over the contemporary computer science literature, and the state of the science on human computer interfacing. Nevertheless, my hope is that what I have covered here serves to excite and motivate researchers from both sciences to seek out greater integration of the two fields through fruitful collaboration.

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