



Act-frequency signatures of the Big Five

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ABSTRACT

The traditional focus of work on personality and behavior has tended toward “major outcomes” such as health or antisocial behavior, or small sets of behaviors observable over short periods in laboratories or in convenience samples. In a community sample, we examined a wide set (400) of mundane, incidental or “every day” behavioral acts, the frequencies of which were reported over the past year. Using an exploratory methodology similar to genomic approaches (relying on the False Discovery Rate) revealed 26 prototypical acts for Intellect, 24 acts for Extraversion, 13 for Emotional Stability, nine for Conscientiousness, and six for Agreeableness. Many links were consistent with general intuition—for instance, low Conscientiousness with work and procrastination. Some of the most robust associations, however, were for acts too specific for a priori hypothesis. For instance, Extraversion was strongly associated with telling dirty jokes, Intellect with “loung[ing] around [the] house without clothes on”, and Agreeableness with singing in the shower. Frequency categories for these acts changed with markedly non-linearity across Big Five Z-scores. Findings may help ground trait scores in emblematic acts, and enrich understanding of mundane or common behavioral signatures of the Big Five.

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1. Behavioral markers of the Big Five

The Big Five were derived from lexically encoded person descriptors, and then labeled for general understanding. Phrases such as “high in Neuroticism,” “low in Conscientiousness,” and so forth may have some intuitive meaning to personality researchers, non-personality oriented psychologists, and the lay public alike. But what exactly is meant by the statement that person X is “highly Agreeable”? Such questions demand some sort of reference phenomenon with intuitive meaning, in which a measurement of “high” (or low, medium, etc.) levels of a trait can be cast (Blanton & Jaccard, 2006a, 2006b). Because they are the top of a hierarchy of more specific traits, broad-band constructs such as the Big Five can pose challenges for concrete reference phenomena since they may correspond to numerous concrete metrics.

1.1. The act frequency approach

One line of work aimed more explicitly at behavioral characterization of the Big Five focuses on mundane or incidental behaviors that make up everyday life, and originates in the Act Frequency Approach (AFA) (Buss & Craik, 1981). The original intent of the AFA was to obtain

numerical frequency ratings of a behavior across a given time period (i.e., an hour, a month, a year). Actual methodology substituted the number of distinct behaviors performed at least once for the number of times any given behavior was performed. The AFA was criticized as too positivistic, in that it would delimit personality to observable behavior (Block, 1989). Since most accept the existence of internal states and see them as integral to personality, this argument seems compelling. However the “observable” critique could be dropped in approaches employing self-reports of behavior.

The early AFA work provided valuable inroads by having college students generate several dozen behaviors and assign them to personality dimensions similar to the Big Five (Buss & Craik, 1981). More recent work has proposed a list of behavioral indicators of Conscientiousness, validating them with the correlations with Conscientiousness measures in undergraduates (Jackson et al., 2010). Frequency measurement of behaviors at differing levels of traits has not been an objective in this work. Counts of behaviors performed at least once in the last year were used in classic AFA work and Likert-type response scales in more recent studies (Jackson et al., 2010). Other studies have addressed behavioral metric issues using speech times in different content categories (Mehl et al., 2006), a temporal intensity metric, or categories of “extremely uncharacteristic” to “extremely characteristic” (Sherman, Nave, & Funder, 2012). True frequency or count metrics seem rare, perhaps because of the analytic challenges they impose: behavioral counts are not likely to change in a linear fashion across trait levels, and thus require generalized linear (i.e. non-linear) models of trait-behavior association (Blanton & Jaccard, 2006a, 2006b).

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1.2. Focus of the Present Study

Our goal was to build on this literature in four ways. First, rather than examining a smaller number of behaviors, we sought to identify “signature” behavioral acts for each of the Big Five from a much larger set (400). Although this by no means represents all conceivable behaviors, it is the largest group of which we are aware, spanning wide content, public and private, and common and uncommon actions. This approach trades tight laboratory control and observer ratings of immediate or induced behaviors for a much wider sampling domain and time frame (i.e., past year). Second, we utilized a set of behavioral acts with actual frequency categories. This approach weds the goal of an intuitively meaningful metric—the simple number of times an act is performed—with a “closed frequency category” response scale designed to reduce the recall bias inherent in reporting a specific number. Third, we employed a lexical measure of the Big Five. Previous work has focused on questionnaire-based measures, which sometimes ask about actual behaviors themselves. For instance, an item on the Conscientiousness scale of the popular NEO-Five Factor Inventory is “I always keep my belongings well organized”. Naturally, such a scale correlates with reported organizational behaviors. However, this may be at least partly due to how the trait is defined, which introduces a circularity or “criterion contamination” that might inflate correlations between reported act frequencies with questionnaire trait measures. Lexical measures, by measuring the Big Five based strictly on trait descriptive adjectives, provide a trait measurement that does not directly incorporate questions about behavioral acts. Fourth, we examined trait-behavior linkages in a community sample. While college samples have provided valuable data thus far, our goal was to identify the most robust act-trait associations in a sample representing a broader swath of society.

2. Methods

2.1. Participants and procedure

Participants were members of the Eugene-Springfield Community Sample (ESCS), a sample of non-institutionalized adults in the Eugene-Springfield, Oregon metropolitan community recruited from lists of home-owners (Goldberg & Saucier, 2016). The personality questionnaire was administered in the summer of 1993 and the behavioral act survey in the fall of 1997. Of 1065 persons with complete personality and demographic data in 1993, 765 completed the behavioral act survey in 1997. The sample had a mean age of 51.4 ($SD = 12.7$), and a modal education level of some college (i.e., 28%, with 20% having a college degree, 17% having levels less than college, and 35% having levels beyond college); 98% were white, and 58% female.

2.2. Measures

2.2.1. Big Five 100 trait-descriptive adjectives (TDA-100)

This inventory consists of 100 adjectives measuring the Big Five (Goldberg, 1992). Each Big Five factor is assessed by 20 adjectives, to which persons report their resemblance on a 1–5 Likert scale. Both positive and negative adjectives are included, and factorial and convergent validity evidence is extensive (Goldberg, 1992). We used varimax-rotated principal component scores for each Big Five dimension. Although some argue for the use of principal factor scores, principal component scores can be directly computed and in this case the two sets of scores are nearly perfectly correlated. Thus, we refer use the term “factor” in a general sense throughout this manuscript.

2.2.2. Behavioral acts inventory (BAI)

The BAI consists of a set of 400 behavioral acts spanning a widely varying range of behaviors (Goldberg, 2010). Examples include “checked out a library book,” “painted my toenails,” “yelled at a

stranger,” and “ate spicy food.” The BAI was developed from previous behavioral act lists, revised with the input of community focus groups (see Goldberg, 2010 for details). Acts span a wide range of categories from physical activity, to leisure pursuits and hobbies, personal habits, interpersonal behaviors, health practices, work behaviors, and many other domains. The complete list can be found in the online supplement Table 10. Participants were asked to report the frequency with which they performed each act using the following rating scale: (1) “never in my life,” (2) “not in the past year,” (3) “once or twice in the past year,” (4) “three to 15 times in the past year,” (5) “15 or more times in the past year.” The frequencies in these rating categories were designed to minimize recall error, since people are not likely to know the exact number of times they performed a behavior, but tend to be able to recall their behavioral frequency within these broad categories.

2.3. Analyses

Our primary question involved culling through 400 different acts to identify a relatively small number of reported behaviors highly associated with each Big Five domain. As with studies examining a large number of genetic variants for associations with a phenotypic trait, this problem demands rigorous attention to multiple testing. We thus imposed a low critical alpha level of $p < 0.001$, deeming a Type 1 error rate of 1 in 1000 acceptable for an exploratory study. From the acts significant by this criterion, we selected an additional set of “signature” behaviors significant according to the more stringent False Discovery Rate (FDR; Benjamini & Hochberg, 1995). In this analysis the critical threshold emerging for FDR control at 0.05 was $ps < 0.000147$.

Our secondary goal involved quantifying trait-behavior associations so that different levels of a trait could be benchmarked with the frequencies at which its signature behaviors occur. Therefore, we used ordinal logistic regression, a type of model equipped to deal directly ordered categories, and controlled for age, gender, education. We estimated average marginal effects, which are covariate-adjusted probabilities for each behavioral frequency category at Z-scores of -1 , 0 , and 1 of a given trait. Gender specific acts (i.e., “Got a breast exam,” “Got a testicular exam”) were examined only in relevant genders. Partial correlations controlling for the same set of demographics revealed essentially similar results. Finally, secondary analyses examined all associations using simple Pearson correlation coefficients.

3. Results

3.1. Specific behavioral signatures of the Big Five

Table 1 reports the behavioral acts associated with each Big Five dimension. The top portion of the table includes acts significant by the FDR rejection threshold, while the bottom includes additional acts achieving a high level of significance ($ps < 0.001$). At least eight “signature” acts were identified for all Big Five dimensions except Agreeableness, for which a relatively smaller number appeared. A few behavioral acts were associated with more than one dimension, but in opposite directions. For instance, buying or reading more books increased in frequency with increasing levels of Openness, but decreased in frequency with higher levels of Conscientiousness. This was not due to correlations among Big Five scores, which were orthogonal. In general, Extraversion was associated with behaviors reflecting social and physical stimulation, Agreeableness with some domestic tasks, Conscientiousness with the avoidance of irresponsible behaviors, low Emotional Stability with various types of self-medication, and Intellect with a range of bohemian, cognitively stimulating, and non-conformist acts.

3.2. Frequencies of signature behavioral acts across levels of the Big Five

Supplement Tables 1–5 show the marginal probability of performing each “signature” act at given frequencies for low, average, and high

Table 1
Behavioral acts associated with each Big Five factor.

Factor I Extraversion	Factor II Agreeableness	Factor III Conscientiousness	Factor IV Emotional stability	Factor V Intellect
Associations with $p < 0.000147$				
Participated in an exercise program	Sang in a car or shower	(Did not) spend an hour at a time day dreaming	(Did not) take tranquilizing pills	Spent an hour at a time day dreaming
Drank whiskey, vodka, gin, or other hard liquor	(Did not) become intoxicated	(Did not) swear around other people	(Did not) make fun of someone	Meditated
Went running or jogging		(Did not) buy a book	(Did not) swear around other people	Swore around other people
Drove while talking on the phone		(Did not) eat something spicy for breakfast	(Did not) take a sleeping pill	Bought a book
Drank in a bar		(Did not) let work pile up until just before a deadline	(Did not) drink alcohol or use other drugs to make myself feel better	Lounged around my house without clothes on
Talked on a cellular phone		(Did not) have an overdue fine for a movie rental or library book	(Did not) take medication for depression	(Did not) Follow a sports team closely
Told a dirty joke		(Did not) read a book	(Did not) have a nightmare	Read poetry
Tried to get a tan		(Did not) chew on a pencil	(Did not) take three or more different medications in the same day	Tried something completely new
Played golf				Bought organic food
Discussed ways to make money				Produced a work of art
Cheered loudly at a sports event				Ate something spicy for breakfast
Decorated a room				Discussed ways to make money
Used a sauna or hot tub				Smoked marijuana
				Attended an art exhibition
				Attended an opera or orchestra concert
				Repaired or did maintenance on a car myself
				Composted food scraps or yard waste
Additional associations with $p < 0.001$				
Swore around other people	Ironed clothes	(Did not) sleep past noon	(Did not) drink four or more soft drinks a day	Shot a gun
Asked questions in a meeting or lecture	(Did not) make fun of someone		(Did not) spend an hour at a time daydreaming	Played piano or another instrument
Planned a party	Played with a child		(Did not) read personal ads	Made an entry in a diary or journal
Drove a car over 75 miles per hour	Washed dishes		(Did not) lose my temper	Finished a large project
Gave a prepared talk or public recital			(Did not) diet to lose weight	Talked in a language other than English
Volunteered for a club or organization			(Did not) drive faster than normal because I was angry	Painted a picture
Discussed sexual matters with a female friend				Cooked a complete meal
Discussed sexual matters with a male friend				Read a book
Did an imitation or impersonation of another person				
Gambled with cards or dice				
Flew in an airplane				

Notes: The top section presents acts with rejected null hypotheses according to False Discovery Rate q -value ($ps < 0.000147$). The bottom section reports additional acts using a cut-off of $p < 0.001$. Acts with "did not" preceding them indicate inverse associations with original positively stated items.

levels of the associated trait. Because different behaviors have different base rates, it is helpful to identify the steepest frequency gradients by considering the ratio of probability at high vs. low levels the trait. Dangerous or unconventional behaviors had somewhat lower base rates, but reasonably steep frequency gradients along their associated Big Five dimensions. For instance, driving while talking on the phone more than 15 times a year was (probability ratio of $0.12/0.05 =$) 2.4 times more likely at high (+1 SD), relative to low (−1 SD) Extraversion. Drinking to intoxication more than 15 times a year was ($0.05/0.02 =$) 2.1 times more likely at low relative to high Agreeableness. Lounging around one's house without clothes on more than 15 times the prior year was ($0.04/0.02 =$) 2 times more likely at high, relative to low Openness. One behavioral frequency category—*never* buying or reading a book *in one's life*—was not endorsed by anyone in the sample.

At the other extreme, swearing around other people was relatively prevalent. Thus, even though this behavior decreased with increasing Conscientiousness, there was still a 25% chance that persons +1 SD in Conscientiousness had cursed around others more than 15 times in the past year.

Secondary analyses of correlations revealed highly similar results (Supplement Tables 6–7, and Figs. 1–5). Most correlations ranged between 0.2 and 0.3 in absolute magnitude. Criterion-keyed scales formed by summing the top 10 acts for each Big Five domain tended to correlate 0.3 to 0.4 with their respective Big Five domain (Supplement Table 9). Regression of each act on all Big Five domains simultaneously produced maximal multiple R s around 0.4 (Supplement Table 10). Finally, sensitivity analysis examining interactions between traits and demographic factors did not reveal any moderation effects significant by FDR.

4. Discussion

4.1. Big Five descriptive interpretations and measurement implications

Signature acts may inform the development of complementary, behaviorally based measures of the Big Five. Secondary correlational analysis suggested that the top 10 behaviors formed ad-hoc criterion-keyed scales having moderate, but not high convergence with a traditional trait-descriptive adjective measure. Thus more work appears necessary to construct such scales, perhaps beginning with the present results and adding new behaviors, and/or considering different weighting schemes. One measure already exists for Conscientiousness (the Behavioral Indicators of Conscientiousness, or BIC), using (a) behaviors generated by content experts rather than empirically selected, (b) response categories ranging from “never performed the behavior” to “performed the behavior quite often” rather than frequency categories, and (c) college rather than community sample respondents (Jackson et al., 2010). Despite these differences, our analysis revealed several similar Conscientiousness behaviors.

In evaluating the specific Big Five signature acts identified here, it may be useful to consider three classes. The first class consists of behaviors that might be naturally attached to particular Big Five dimensions, a priori. These behaviors are analogous to content-based, face-valid indicators that later emerge as marker items on a factor. The second kind of behaviors is those one might associate with a Big Five domain only after seeing the results. Such behaviors have an “of course, that makes sense” quality to them after the fact. Some of these acts may be particularly useful in mildly “disguising” a Big Five scale by including less face-valid content. And, finally, there is a small set of signature acts that appear flatly counter-intuitive. This is analogous to a “surprise” marker item on a factor that was supposed to load on an entirely different one. This type of behavioral indicator, if replicated in other investigations, might be of use when there is a need to completely conceal the Big Five domain being measured.

4.2. Theoretical characterization of the Big Five

4.2.1. Extraversion

Analyses of trait-descriptive terms in English and other languages suggest that the core aspects of the Extraversion factor include Activity Level/Energy Level, Assertiveness, and Gregariousness (e.g., Goldberg, 1990). In the present analyses, these components were reflected in the identification of behaviors indicative of social activity (talked on a cellular phone, planned a party) as well as social confidence and dominance (asked questions in a meeting or lecture, gave a public talk or planned presentation). However, our results also indicated that one of the most prominent behaviors of extraverted people is the discussion of ways to make money. This is, at first glance, not something one immediately associates with Extraversion, at least not as a prototypic behavioral marker. However, this is consistent with reward reactivity, and some evidence suggests generally higher earnings and occupational success for extraverts, and these achievements may be attributed to their charismatic interpersonal qualities (Judge, Bono, Ilies, & Gerhardt, 2002).

Positive affect also appears to be a core facet of Extraversion (Lucas, Diener, Grob, Suh, & Shao, 2000). Behaviors inducing positive affect (told a dirty joke, cheered loudly at a sporting event), sometimes in a hedonic way (drank in a bar, sat in a sauna or hot tub) were also singular markers of Extraversion. Individuals higher in Extraversion claimed to discuss sex more often, consistent with the finding that they tend to have more sexual partners (Nettle, 2006). As well, the “dark side” of Extraversion was apparent in behaviors related to sensation seeking (drove more than 75 miles an hour, talked on a cellular phone while driving, drank whiskey, gin, vodka, or hard liquor). Extraversion has previously been linked to dangerous driving (Lajunen, 2001), and drinking behaviors may reflect the desire for social stimulation as well as

intoxication (Malouff, Thorsteinsson, Rooke, & Schutte, 2007). Some forms of physical activity, which also stimulate pleasure circuitry (i.e., the “runner’s high”), were also found for Extraversion (went running or jogging, participated in an exercise program, played golf). The activity component of Extraversion entails a sense of vitality and vigor known to be facilitated by regular exercise (Rhodes, Courneya, & Jones, 2005).

4.2.2. Agreeableness

Few specific behavioral markers were identified for Agreeableness using the relatively stringent statistical criterion we employed. Agreeableness may be weakly associated with a larger number of acts, with relatively few highly distinguishing behaviors. Another possibility is that the sampling domain spanned by our 400 behavioral acts simply undersampled behavioral signatures of Agreeableness. However, Agreeable persons did show trends toward behaviors that either directly or indirectly benefited others, controlling for gender (ironed clothes, washed dishes, played with a child), consistent with the desire for interpersonal harmony that characterizes Agreeableness. Interestingly, singing in the shower was one of the most robust markers of this Big Five dimension. Persons lower in Agreeableness also admitted they “became intoxicated” more often over the prior year than those higher in Agreeableness.

4.2.3. Conscientiousness

Persons high in Conscientiousness rarely did things like “sleep till noon,” “let work pile up until just before a deadline,” accrue late fees for books or videos, or daydream. These all reflect the facets of responsibility and organization found in examinations of the component structure of Conscientiousness (Roberts, Chernyshenko, Stark, & Goldberg, 2005). Social propriety and self-control were reflected in less frequent cursing. Chewing on pencils was singularly (and inversely) linked to Conscientiousness as well. This apparently unremarkable act may reflect the neglect of hygiene and cleanliness denoting low Conscientiousness (Jackson et al., 2010), but may serve as an indicator of procrastination in written activity. One rather curious behavior was the tendency for Conscientious persons to buy and read books less often. This seems counter-intuitive because Conscientiousness, on the whole, is characterized by desirable behaviors. However, to the extent that Conscientious persons work long hours to achieve goals, time for reading may be perceived as a rare luxury.

4.2.4. Emotional stability

Most of the behaviors describing low levels of Emotional Stability reflected efforts to cope with stress either legally (took “tranquilizing pills,” “a sleeping pill,” “medication for depression,” “three or more medications in the same day,” “drank alcohol”) or feloniously (“used other drugs to make myself feel better”). Since Neuroticism is defined by mood dysregulation and is a risk factor for many types of psychiatric distress, it leads to greater mental health service utilization (Goodwin, Hoven, Lyons, & Stein, 2002) and thus access to prescription medication. Poor nutrition (“drank four or more soft drinks a day”), possibly also a self-medication strategy, and accompanying dissatisfaction with one’s body (“went on a diet”), were also consistent with neurotic persons’ generally worse eating habits (Goldberg & Stycker, 2002) and weight gain (Sutin, Ferrucci, Zonderman, & Terracciano, 2011).

Behaviors denoting anger or hostility were also highly characteristic of low Emotional Stability (“swore around other people,” “made fun of someone,” “drove too fast because I was angry”). Such activities are often considered indicative of low Agreeableness, whereas low Emotional Stability is often conceptualized as negative affect not specifically related to anger (anxiety and depression, principally). The Five Factor Model, however, includes a facet of “angry hostility” for Neuroticism (Costa & McCrae, 1992). In the Big Five or lexical tradition, “vindictiveness,” “temper,” and “antagonism” adjective clusters load on the low end of Agreeableness. Finally, persons lower in Emotional Stability had more nightmares—an oft-forgotten correlate of Neuroticism that, in

fact, was a major marker of the trait in the early Eysenck Personality Inventory (Eysenck & Eysenck, 1964).

4.2.5. Intellect

An abundance of behaviors distinguished between high and low levels of Intellect. Obvious among these were contemplative (“spent an hour at a time daydreaming,” “meditated”), aesthetic (“played piano or another instrument,” “painted a picture,” “produced a work of art,” attending art exhibitions and orchestras), and literary acts (bought or read books, “talked in a language other than English,” “made an entry in a diary or journal”). However, Intellect has also been described as a tendency to defy convention or orthodoxy, possibly as a result of novelty seeking. This non-conformist tendency was also clear in several behavioral acts (“tried something completely new,” “lounged around my house without clothes on,” “smoked marijuana”). To a small extent, the behavioral signatures indicative of high Intellect were opposite those of high Conscientiousness: four different behaviors were linked to both domains, but in opposite directions (“cursed or swore around others,” “bought a book,” “read a book,” “ate something spicy for breakfast”). An underlying dialectic of convention and task focus (Conscientiousness) vs. rebellion and intellectual focus (Intellect) may be a useful conceptual frame for the behavioral tendencies differentiating these two factors.

4.3. Limitations and future directions

These findings must be interpreted with a balanced understanding of our study’s qualifications and strengths. First, the behavioral acts we identified should not be interpreted as a complete catalogue of all behaviors associated with each Big Five dimension. We selected only the most robustly characteristic acts for each dimension, from a set of 400 behavioral acts. Tens of thousands of such acts might be investigated. We also studied a community sample, and it would be particularly interesting to examine Big-Five related behavioral signatures across different cultural groups. Indeed, any generalizations must be made with careful regard to the characteristics of this sample. Some behavioral acts have secular context, meaning their frequencies may change with societal change. In other cases, acts of the same nature may be performed through different modalities, such as reading a newspaper online rather than in print. Finally, the behavioral acts we studied were self-reported. Observer ratings of behaviors will certainly be important as a converging line of evidence. Tradeoffs exist between the two methods: while observer reports provide an inter-subjective perspective, it would be virtually impossible to record hundreds of behaviors across all situations, particularly private ones (Goldberg, 2010). A literature also exists on contextual manifestation of personality (for instance, the messiness of one’s room; Gosling, Ko, Mannarelli, & Morris, 2002). The acts studied here may in some cases proxy these contextual cues, or dovetail with them in everyday life and future work might bridge these literatures. Our study’s strengths included a rigorous search strategy across the largest behavioral set of which we are aware, combined with a statistical approach rigorous enough for exploratory work but balanced in Type I and Type II error tradeoffs. To our knowledge, probabilistic behavioral frequency estimates across varying levels of the Big Five also have yet to be reported. In sum, our findings point toward the possibility of eventually supplementing traditional trait measurement approaches with signature behavioral acts.

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Supplementary data

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