Clarifying the Linguistic Signature: Measuring Personality From Natural Speech

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In this study, we examined the viability of measuring personality using computerized lexical analysis of natural speech. Two well-validated models of personality were measured, one involving trait positive affectivity (PA) and negative affectivity (NA) dimensions and the other involving a separate behavioral inhibition motivational system (BIS) and a behavioral activation motivational system (BAS). Individuals with high levels of trait PA and sensitive BAS expressed high levels of positive emotion in their natural speech, whereas individuals with high levels of trait NA and sensitive BIS tended to express high levels of negative emotion. The personality variables accounted for almost a quarter of the variance in emotional expressivity.

Verbal expression is widely considered to be one of the pinnacle features of human cognition (Crow, 2000; Premack, 2004). That being said, there is considerable variability in how verbal information is expressed across people, and clarifying these individual differences has been important for understanding how humans adapt and function across a wide array of environments (Pennebaker & King, 1999). Not surprisingly, there has been considerable effort to develop methods of evaluating verbal expression. One approach involves systematic analysis of the words that individuals use to express themselves (e.g., general inquirer; Stone, Dunphy, & Smith, 1966; autobiographical analysis; McAdams, 2001). Recent advances in computerized processing speech have allowed for automated procedures that are both efficient and can be applied to a wide range of applications. In the following report, we focus on a computerized methodology known as “lexical analysis,” which employs a “word count strategy” to match words and phrases to a standardized dictionary. In this manner, the instances of specific types of verbal expression can be evaluated.

A relatively large corpus of research has accumulated on individual differences in verbal expression using lexical analysis. Topics include the study of psychotherapy outcome (Bucci 1995; Pennebaker, 1997), severe psychopathology (Cohen, Alpert, Nienow, Dinzeo, & Docherty, 2008; Cohen, St-Hilaire, Aakres, & Docherty, in press), emotional experience during mood induction (Orsillo, Batten, Plumb, Luterek, & Roesnner, 2004), reactions to traumatic experiences (MacGeorge, Samter, Feng, Gillihan, & Graves, 2004), literary art (Dijkic, Oatley, & Peterson, 2006), political discourse (Pennebaker & Lay, 2002), and deceitfulness (Newman, Pennebaker, Berry, & Richards, 2003). Lexical analysis of words relating to emotional expression (e.g., sad, happy) have proved particularly useful for understanding psychological processes. For example, individuals show increased use of positive words and decreasing negative words as they recover from depression (Pennebaker, Mehl, & Niederhoffer, 2003), individuals with schizophrenia show abnormally increased use of negative emotion words when recounting emotionally charged memories (Cohen et al., in press), and individuals with alexithymia have shown decreased use of emotion words more generally (Tull, Medaglia, & Roemer, 2005). In short, lexical analysis has proved to be an invaluable tool for measuring psychopathology and higher order psychological processes.

Although idiosyncrasies in verbal expression and dispositional differences have been examined in a handful of studies (e.g., during Rorschach or Thematic Apperception Test [Murray, 1943] assessments; Leichsenring & Sachsse, 2002; Rosenberg, Blatt, Oxman, McHugo, & Ford, 1994; Schnurr, Rosenberg, & Oxman, 1992), little is known about how basic “building blocks” of personality relate to lexical expression. Pennebaker and King (1999) reported modest but significant correlations between basic personality measures (assessed using the Five-factor personality model) and lexical expression measures in an examination of written essays from 1,203 undergraduates. Notable associations were reported between “neuroticism” and increased use of negatively valenced emotional words \( r = .16 \) and “extroversion” and increased positively valenced emotional words \( r = .15 \). Similar magnitudes of correlations (although generally not statistically significant) were reported between five-factor personality measures and lexical expression variables in an experience sampling study using randomly recorded subject’s natural speech (Mehl, Gosling, & Pennebaker, 2006). One limitation of these studies is that the verbal material was collected without regard to content. Thus, there was little assurance that the verbal material contained any autobiographical or personally relevant information.

In this study, we assessed the degree to which basic elements of personality can be measured using lexical analysis of verbal expression. We focused on affective features of personality in
light of lexical analysis’s documented ability to measure affective aspects of verbal expression. We selected two well-validated models of personality. The first, the Positive and Negative Affect Scale (PANAS; Watson & Clark, 1999), measures separate (but not entirely orthogonal) positive and negative affectivity traits that reflect enduring pleasurable and dysphoric emotions, respectively. The second, based on neurobiological models of human motivation, measures a separate behavioral inhibition system (BIS) and a behavioral activation system (BAS) that reflect enduring motivations away from or toward external objects (Carver & White, 1994). We predicted that both positive affectivity and behavioral activation would be associated with higher levels of positively valenced word use. Conversely, we predicted that both negative affectivity and behavioral inhibition would be associated with higher levels of negatively valenced word use.

**METHODS**

**Subjects**

Subjects were 35 men and 33 women recruited from a large public university in the Southeastern United States. Subjects received course credit for participating in this experiment. Based on findings that lexical expression differs dramatically between ethnic groups, particularly Asian Americans and Whites (Fernandez, Carrera, Sanchez, Paez, & CANDIA, 2000; Tsai, Simeonova, & Watanabe, 2004), this analyses excluded Asian participants. Additionally, 5 participants. It is noteworthy that re-computation of the analyses in this study using only White subjects yielded no demonstrable change in findings. Descriptive statistics are provided in Table 1. This study was approved by the appropriate institutional review board, and all subjects provided written informed consent prior to beginning the study.

**Table 1.—Demographic and descriptive data for subjects including means and standard deviations (M ± SD) for affect and personality measures.**

<table>
<thead>
<tr>
<th>Demographic Information</th>
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<tbody>
<tr>
<td>Gender</td>
</tr>
<tr>
<td>Males (n)</td>
</tr>
<tr>
<td>Females (n)</td>
</tr>
<tr>
<td>Age (years; M ± SD)</td>
</tr>
<tr>
<td>Ethnicity (n)</td>
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<tr>
<td>African American</td>
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**Affect and Personality Measures (M ± SD)**

<table>
<thead>
<tr>
<th></th>
<th>M ± SD</th>
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<tbody>
<tr>
<td>State affect</td>
<td>3.53 ± 1.50</td>
</tr>
<tr>
<td>Trait Negative Affect</td>
<td>47.68 ± 12.98</td>
</tr>
<tr>
<td>Trait Positive Affect</td>
<td>62.53 ± 6.78</td>
</tr>
<tr>
<td>Behavioral Inhibition System</td>
<td>12.68 ± 3.58</td>
</tr>
<tr>
<td>Behavioral Activation System</td>
<td>23.72 ± 4.68</td>
</tr>
<tr>
<td>Word count</td>
<td>470.51 ± 121.03</td>
</tr>
<tr>
<td>% Positive Emotion Words</td>
<td>2.55 ± 0.96</td>
</tr>
<tr>
<td>% Negative Emotion Words</td>
<td>0.59 ± 0.50</td>
</tr>
</tbody>
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Procedure

Subjects were seated in front of a computer monitor and could not see the interviewer. The experiment was run using Eprime software (Psychology Software Tools, 2002). First, we recorded subjects mood “at that exact moment” using the Self-Assessment Moniker Valence scale (Lang, Bradley, & Cuthbert, 1999), a Likert scale that assesses mood on a scale ranging from 1 (extreme happiness) to 9 (extreme unhappiness). Following this, a head-mount microphone was affixed to the subject to facilitate digital recording of their voice. We displayed the following instructions on the computer monitor while the research assistant read them aloud.1

We want to record you while you talk for 3 minutes. You can talk about any subject you want. Listed following are some suggestions, but please note that the research assistant is unable to help you during this procedure. Remember, feel free to discuss anything on your mind.

**Topics included the following:**

1. Talk about yourself and what kind of person you are.
2. What do you do with your time?
3. What do you find interesting?
4. Do you have any hobbies or special interests?
5. Talk about your family.
6. What do you think of the future?
7. Have you set any goals for yourself?
8. How would you change your life if you could?*

Additionally, the following text was read to each subject:

Some people find it difficult to talk for 3 minutes by themselves. If you run into problems, talk about as many details as you can. For example, if you are talking about sewing, you could discuss what you like to sew, what you hate to sew, when you learned to sew, who taught you to sew, your favorite project, where you buy your sewing supplies, etc. Any questions? Let me know when you are ready to begin.

Following completion of the task, subjects were administered a series of personality instruments.

**Assessment Measures**

**PANAS–X.** The PANAS (Watson & Clark, 1999) is comprised of 60 affectively valenced words that subjects indicate the “extent to which they feel this way, generally” using a Likert scale ranging from 1 (very slightly or not at all) to 5 (Extremely). For this study, we used the total Positive Affectivity and Negative Affectivity scores (defined in Watson & Clark, 1999). These scales have shown acceptable test–retest reliability for 2-month and 7-year intervals and high convergence with other personality instruments (Bagozzi, 1993; Watson & Clark, 1999).

**BIS and BAS scales.** The BIS/BAS scales (Carver & White, 1994) are comprised of 24 items that assess individuals’ enduring style of relating with their environment. Subjects respond on a scale ranging from 1 (very true for me) to 4 (very false)

1The instructions were written based on prior experience (Cohen, et al., 2008). We gave particular attention to balancing subjects’ freedom to determine their own topics of speech while encouraging them to discuss personally relevant material. We felt the open-ended instructions in the script coupled with the probes offered this balance.
other measures (range of Cohen’s d values = .00 [LIWC negative emotion] to .90 [LIWC positive emotion]). Age was not significantly correlated with any of the LIWC or personality measures (range of r values = .00 [BIS total] to .17 [PANAS negative emotion]). It is noteworthy that each of the variables examined in this study were normally distributed. We report two-tailed statistics here.

The bivariate correlations between the lexical and state and trait measures are presented in Table 2. The state measure of affect was not related to either of the lexical measures, but increasing state negative affect significantly corresponded to increasing trait negative affect. As hypothesized, subjects with higher levels of trait positive affect and higher BAS sensitivity tended to express more positive emotion in their speech. Moreover, subjects with higher trait negative affectivity and higher BIS sensitivity tended to express more negative emotion. When interpreting these findings, it is important to note that the trait affectivity and BIS/BAS measures were only modestly intercorrelated, suggesting they were by no means redundant with each other.

As noted by Carver and White (1994), the BAS is multifaceted, comprised of three separate factors including (a) drive to pursue reward, (b) impulsivity and fun-seeking behaviors, and (c) reward responsivity factors. We used bivariate correlations to determine the magnitude of relationships between verbal expression of positive emotion and the drive, r(66) = .32, p < .01; fun seeking, r(66) = .33, p < .01; and the reward responsivity, r(66) = .03, ns. factors. These results suggest that the drive and impulsivity/fun seeking but not reward responsivity aspects contributed to verbal expression of positive emotions.

To determine the total magnitude of contribution that the trait measures made to verbal expression of emotion, we computed regressions set up so that the total emotion words expressed (computed as a sum of LIWC positive and negative categories) were the dependent variable, and all four personality scores were entered in a single step. The predictor variables accounted for almost a quarter of the variance in verbally expressed emotion (ΔR = .23, ΔF = 2.99, p < .05).

DISCUSSION

In this study, we sought to determine the relationship between basic personality and verbal expressivity of emotion. Individuals with high levels of trait positive affectivity and those with sensitive BAS tended to express more positive emotion in their
natural speech. Individuals with relatively high levels of trait negative affectivity and those with more sensitive BIS tended to show more negative emotion in their natural speech. In total, the personality variables explained almost a quarter of the variability in emotion expressivity across individuals. These results are more robust than those that have been reported in prior studies (Mehl et al., 2006; Pennebaker & King, 1999), owing at least in part to our use of a more carefully controlled speech-acquisition procedure. Although the utility of using computerized lexical analysis for measuring aspects of mental health and higher order cognitive functions are well documented (see beginning of this article), this study is one of few to demonstrate the potential for understanding basic elements of personality in the laboratory.

The potential applications of measuring personality using lexical analysis are many. Benefits of this procedure over more traditional questionnaire-based personality instruments are that administration time is brief (3 min in this study), the analysis is automated, administration can be conducted with minimal training, and the analysis parameters can be modified to suit specific research questions. Ultimately, this procedure may have broad appeal to social scientists as a proxy measure of personality or as a behavioral criterion index to validate measures of speech-relevant personality domains. In our line of research, we are attempting to understand how individual differences in affective temperament contribute to outcome in individuals with schizophrenia spectrum disorder (see Cohen, Alpert, et al., in press; Cohen et al., 2005; Cohen & Docherty, 2004). Given the limitations in self-report of emotion in patients with severe mental illness (e.g., communication disorders, high levels of alexithymia, blunted affect), lexical analysis is an attractive method for measuring emotion in this population. These findings serve as an important benchmark as we examine the viability of lexical analysis for use in psychopathology research.

Considerable work remains to validate lexical analysis for measuring personality. First, given that current procedures give all emotional words equal weight, the sensitivity of the dictionaries could be improved. It is possible that a weighting procedure based on emotion valence or intensity could be derived, perhaps informed by the burgeoning literature on lexicons and personality constructs (e.g., Stevenson, Mikels, & James, 2007, Ashton, Lee, & Goldberg, 2004). Second, there are a number of individual difference variables that will need to be examined such as ethnicity, the presence of personality disorders, alexithymia, verbal ability, low insight, and communication disorders. We limited our study to Whites and African Americans, and there were notable (but nonsignificant differences) in positive emotion expression even between these two groups. Third, it will be important to determine whether other features of personality, such as agreeableness, openness to experience, and conscientiousness, can be accurately captured using lexical analysis. Finally, given that this was essentially a study of convergent validity, other psychometric properties of the lexical analysis procedure will need to be evaluated. It will be particularly important to determine the temporal stability of the lexical analysis variables and their external validity, notably, whether they correspond to any meaningful measures of social, academic, vocational functioning or subjective or objective quality of life variables.

This study was limited in that the measure of state affect, although commonly employed in basic emotion research, may not have been sensitive enough to show association with the lexical analysis variables. Second, in the absence of a “control” condition involving free speech about autobiographical content, it is unclear to what degree the expression of personality is unique to “self-directed speech.” Third, the sample was comprised of college students who are by no means representative of all people. Finally, we lacked power to examine the role of gender or ethnicity in any meaningful way.

In summary, these data contribute to the growing support for lexical analysis as a quantitative and automated method of evaluating basic personality from autobiographical text (e.g., Winter, 2005; Pennebaker & Lay, 2002). The potential for understanding personality in the context of laboratory study is particularly promising, as most current methods are based on subjective appraisals using standardized questionnaire formats. Lexical analysis offers a potentially sophisticated and sensitive measure of personality with a wide range of applications. Additional study will be required to further validate this measure.

REFERENCES


Psychology Software Tools, Inc. (2002). E-Prime 1.2 [Computer software].


