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# The normalities and abnormalities associated with speech in psychometrically-defined schizotypy

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ABSTRACT

Speech deficits are thought to be an important feature of schizotypy — defined as the personality organization reflecting a putative liability for schizophrenia. There is reason to suspect that these deficits manifest as a function of limited cognitive resources. To evaluate this idea, we examined speech from individuals with psychometrically-defined schizotypy during a low cognitively-demanding task versus a relatively high cognitively-demanding task. A range of objective, computer-based measures of speech tapping speech production (silence, number and length of pauses, number and length of utterances), speech variability (global and local intonation and emphasis) and speech content (word fillers, idea density) were employed. Data for control ($n = 37$) and schizotypy ($n = 39$) groups were examined. Results did not confirm our hypotheses. While the cognitive-load task reduced speech expressivity for subjects as a group for most variables, the schizotypy group was not more pathological in speech characteristics compared to the control group. Interestingly, some aspects of speech in schizotypal versus control subjects were healthier under high cognitive load. Moreover, schizotypal subjects performed better, at a trend level, than controls on the cognitively demanding task. These findings hold important implications for our understanding of the neurocognitive architecture associated with the schizophrenia-spectrum. Of particular note concerns the apparent mismatch between self-reported schizotypal traits and objective performance, and the resiliency of speech under cognitive stress in persons with high levels of schizotypy.



## 1. Introduction

Several recent articles in Schizophrenia Research have employed relatively sophisticated computerized analysis of communication to understand deficits in individuals with schizotypal characteristics (Dickey et al., 2012; Cohen et al., 2013). The magnitude of deficits has tended to be negligible to small. This is surprising since these same individuals self-report high levels of communication deficits (i.e., 1–2 standard deviations in Cohen et al., 2010; Kerns and Becker, 2008). Communication is an inherently dynamic process and varies as a function of a host of contextual variables. It could be the case that communication deficits manifest only in certain contexts or situations. We sought to evaluate the relationship between cognitive resources and speech deficits in schizotypy. Generally speaking, effective communication draws on attentional and other cognitive functions, and a lack of availability of these cognitive resources can result in reduced speech productivity and variability (Barch and Berenbaum, 1997; Almor, 2008). Thus, limitations in "on-line" cognitive capacity present at a small degree in schizotypy (for a recent meta-analysis, see Chun et al., 2013) may affect speech when taxed (i.e., under "cognitive load"). A prior study from our lab tested this notion in individuals with psychometric schizotypy and controls (Cohen et al., 2012). All subjects showed a decline in speech productivity and speech variability when under cognitive load, but this was not demonstrably different for individuals with schizotypy versus controls. The present study more meaningfully explored the relationship between cognitive resources and diminished speech expressivity by employing a more sophisticated design, and expanding our computerized measures of speech in terms of sensitivity and breadth. Diminished speech expression may reflect a vulnerability marker of schizophrenia and understanding its nature may provide critical insights about the schizophrenia-spectrum.

## 2. Methods

The Schizotypal Personality Questionnaire — Brief Revised (SPQ-BR; Cohen et al., 2010) was administered to University students (N of completed responses = 2303). Individuals scoring in the 95th percentile on the positive or disorganization and/or negative subscales from the SPQ-BR were considered eligible for the present study (N schizotypy = 39). Thirty-seven control subjects, selected from participants scoring below the gender-determined means for each of the SPQ-BR subscales, and from denying family history of schizophrenia, were also recruited. Subjects were excluded if they endorsed a personal history of schizophrenia diagnosis. Cognitive ability was measured using the Brief Assessment of

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Cognition in Schizophrenia (BACS; Keefe, 1999). This study was carried out in accordance with The Code of Ethics of the World Medical Association for human experiments. Demographics are provided in Table 1.

### 2.1. Cognitive-load speech task

Speech was captured during separate counter-balanced 90-second "low" (i.e., no competing task) and "high" load tasks narrative tasks involving discussion of affectively neutral topics (i.e., hobbies, foods). During the "low-load" task, participants provided speech while watching symbols appear on the screen. During the "high-load" task, participants provided speech while performing a one-back test (see Cohen et al., 2012). The present task was more demanding than that used in our prior study in that subjects responded both to targets and non-targets as opposed to only targets (as in Cohen et al., 2012). The A′ and response bias from the 1-back task are reported here.

### 2.2. Computerized assessment of speech

The Computerized assessment of Affect from Natural Speech protocol (CANS; see Cohen et al., 2012) was employed. Speech was digitally recorded and analyzed by organizing sound files into "frames" for analysis (i.e., 100 frames/s; PRAAT; Boersma and Weenink, 2006). During each frame, frequency and volume is quantified. We examined the following variables in this study: word count — number of words expressed during the speech sample, pause number — total count of all pauses in the speech sample, pause length — mean length of pauses (in milliseconds), utterance length — mean length of utterances (in milliseconds), local intonation — average standard deviation of fundamental frequency values computed separately for each utterance, global intonation — standard deviation of local intonation values across the speech sample, local emphasis — average standard deviation of intensity (i.e., volume) values, computed separately for each utterance, and global emphasis — standard deviation of local intensity values across the speech sample. All fundamental frequency values were log-transformed to control for their nonlinear distribution.

Nonfluencies (e.g., "er", "um", "hm") and fillers (e.g., "I mean", "you know", "blah", multiple word repetitions) were assessed using the Linguistic Inquery and Word Count (LIWC) program to analyze the transcribed speech samples (Pennebaker, 2001). Semantic complexity (i.e., idea density) was measured using CPIDR 5.1 (Computerized Propositional Idea Density Rater, Covington, 2012). CPIDR computes the number of propositions or assertions (verbs, adjectives, adverbs, prepositions, and subordinating conjunctions with some adjustment rules) and divides those by the total number of words in the text. Higher scores indicate more semantically complex text that expresses a greater variety of meaning per volume of text.

**Table 1**
Descriptive statistics for demographic and clinical variables for the control and schizotypy groups.

| | Controls ($n = 37$) | Schizotypy ($n = 39$) |
|---|---|---|
| % male | 37.80 | 38.50 |
| Ethnicity | | |
| % Caucasian | 81.10 | 76.90 |
| % African American | 13.50 | 5.10 |
| % other | 5.40 | 18.00 |
| Age | 19.05 (2.39) | 18.64 (1.22) |
| Family history of schizophrenia[a] | 0.00% | 18.90% |
| Schizotypal traits | | |
| Cognitive-perceptual | 8.00 (.90) | 30.33 (9.64) |
| Negative | 2.92 (2.27) | 11.87 (6.17) |
| Disorganization | 8.00 (4.74) | 25.77 (4.86) |
| BACS *z*-score | −.20 (1.10) | .18 (.87) |
| High-load cognitive task performance | | |
| Mean sensitivity — a′ | .75 (.15) | .80 (.13) |
| Mean response bias — *b* | .25 (.44) | .25 (.45) |

Standard deviations in parentheses.
[a] Percent of participants with at least one family member with schizophrenia.

## 3. Results

The schizotypy and control groups were similar in demographic and cognitive variables ($p$'s > .10), although the schizotypy group performed slightly better than the control group on the BACS ($d = .39$). The schizotypy group showed better $A'$ scores for the one-back task at a trend level, $t(74) = 1.81$, $p = .08$. Family history of schizophrenia was higher in the schizotypy versus control groups, $\chi^2(1) = 6.94$, $p = .008$.

Repeated-measures ANOVAs (see Fig. 1) suggested that, for subjects in general, cognitive load results in lower word counts, fewer and longer pauses, greater global intonation and local emphasis, more filler and less semantically complex content ($p$'s < .05). Greater local intonation ($p < .10$) was also observed at a trend level. Significant group effects suggested that schizotypy was associated with higher word counts and more/shorter pauses and greater local intonation at a significant level ($p$'s < .05); and greater global intonation at a trend level ($p < .10$). Interaction effects were observed for the local intonation and filler variables at a significant level ($p$'s < .05) and for pause length at a trend level ($p < .10$). Schizotypy versus control groups showed less change between low and high conditions in terms of increased pause length (net change = 13% and 25%, respectively) and filler/nonfluency word use (net change = 11% and 60%, respectively). With respect to local intonation, the schizotypy group showed an increase whereas controls showed a decrease (net change = 11% and −3%, respectively). In sum, increased cognitive resources led to changes in speech for subjects as a group but the schizotypy group was not abnormally deficient in speech characteristics.

Correlations computed between the positive, negative and disorganized SPQ subscores and the speech variables failed to reveal any statistically significant relationships for any of the conditions (n = 60 correlations; $p$'s > .05). Post-hoc analyses suggested that sex, age, ethnicity and depression variables were not responsible for the null findings in this study.

## 4. Discussion

The present study tested the hypothesis that cognitive resource limitations contribute to expressive deficits in schizotypy using experimental methods. Overall, many of our results were unexpected, yet still informative about the nature of schizotypy. For participants as a whole, increased cognitive load was associated with changes in most speech characteristics; however, these changes were not more pathological in individuals with schizotypy as compared to controls. Surprisingly, individuals with schizotypy were more resilient to the cognitive demands of the task than controls with respect to important speech characteristics. Of particular note, their use of filler words and nonfluencies was virtually unchanged (11% increase) compared to controls, who showed a relatively dramatic (60%) increase when under cognitive load. Moreover, the subjects with schizotypy performed slightly better than controls on tests of neurocognitive ability (small effect size level), and better on the 1-back task while speaking (at a trend level). While the present findings did not support the notion that constricted affect occurs largely as a function of limited cognitive resources in schizotypy, our unexpected findings — that aspects of communication are less affected by cognitive demands in persons with schizotypy compared to controls — may ultimately prove to be equally interesting and revealing about the nature of schizotypy.