Letter to the Editor

Feasibility of using smartphones to capture speech during social interactions in schizophrenia

To the Editors

Lexical analysis is a tool designed to assess speech content using a variety of categorical labels (e.g., positive affect words, cognitive mechanisms; Pennebaker et al., 2015) and has been used throughout the schizophrenia spectrum to quantify emotional expression. Most studies of lexical analysis in schizophrenia have been conducted in controlled, laboratory settings, and have focused on group differences in word use. Findings suggest, for example, that people with schizophrenia speak fewer total words (St-Hilaire et al., 2008) and show a greater proportion of negative affect words (Fineberg et al., 2016; Cohen et al., 2009) and first-person pronoun words (Fineberg et al., 2016; Buck and Penn, 2015) than people without schizophrenia. Similar findings have been reported among people endorsing schizotypal traits (e.g., Abplanalp et al., 2017). These findings are thought to reflect differences in emotional experience and expression, leading some to suggest that they may help inform understanding of phenomenology of schizophrenia spectrum disorders (Minor et al., 2015).

Although laboratory studies allow for more experimental control, generalizability of findings to word use in daily life may be limited. Recent technological advances have afforded researchers the opportunity to unobtrusively collect data from naturalistic environments via smartphones and other remote devices. Existing studies suggest ambient audio data can provide information distinct from self-reports, and can capture subtler, habitual facets of real-world behavior (Mehl, 2017). However, no study has examined unprompted word use in the context of daily life in schizophrenia using lexical analysis. While prior research has used smartphones to capture ambient audio in other serious mental illness populations (e.g., bipolar disorder; Gideon et al., 2019), data on the feasibility and acceptability of this method have not been presented. To appropriately implement such methods, identifying concerns surrounding privacy, comfort, and interference are essential. This may be particularly relevant in disorders such as schizophrenia, where positive symptoms (e.g., suspicious thought content) might make such approaches more challenging. Therefore, the primary aim of the current study was to examine the feasibility and acceptability of using smartphones to capture naturalistic speech in people with and without schizophrenia.

All participants were recruited from the San Francisco Bay Area and were a part of a larger study (Fulford et al., in press; Mote et al., 2019). Clinical referrals, brochures, and flyers in local clinics were used to recruit individuals with schizophrenia ($n = 20$). Controls ($n = 15$) were recruited via community flyers and public advertisements. All procedures were approved by the San Francisco State Institutional Review Board and all participants provided informed consent.

We used the Ethica mobile research application to record unobtrusive audio from the participants' natural environments. Participants were provided smartphones with the Ethica application (www.ethicadata.com) installed and were programmed to semi-randomly record five-minute intervals of ambient audio every 30 min over a seven-day period. Following study completion, participants reported on the feasibility and acceptability of the study through a survey.

We examined the feasibility and acceptability of the study by summarizing responses to our debriefing survey, which was scored on a 1 ("*Not at all*") to 5 ("*Extremely*") scale. Next, we conducted independent samples *t*-tests comparing those with and without schizophrenia on the total number of 5-minute audio recordings across the seven-day study period, the number of audio recordings per day, and the number of total audio recordings after accounting for corrupt recordings (i.e., recordings lost due to technical error).

Results are presented in Table 1. Both groups found the study smartphone app to interfere relatively little in their daily life. While controls found the app to interfere in their daily life more so than did those with schizophrenia, the mean level of interference was quite low for both groups. Both groups also generally found using the app was not difficult nor uncomfortable, and reported moderate enjoyment from using the app. The two groups did not differ on the total number of ambient audio recordings, the total number of recordings after accounting for corrupt recordings, or the number of ambient audio recordings per day (see Supplemental Table 1).

In this study we examined the feasibility and acceptability of gathering ambient audio in the context of daily life via smartphones in people with and without schizophrenia. We found evidence of feasibility and acceptability of gathering ambient audio via smartphone, as participants from both groups reported minimal inference or discomfort using the smartphone app. We also found no differences in smartphone app performance between the groups, as individuals with schizophrenia and controls had a similar number of ambient audio recordings per day and across the seven-day study period. Importantly, all participants with schizophrenia reported that they would participate in similar future studies.

The major strength of this study was the sheer quantity of audio captured in participants' ambient environments. A total of 811 h of audio was captured across the two groups, equating to approximately 24 h per person in the study. Audio for the current study was captured in five-minute increments, every 30 min for 24 h per day. Social activity is likely to fluctuate depending on the day of the week, or time of day; by not limiting recordings to certain days and times, we were able to capture natural variability in social interactions and word use by using non-invasive smartphones. Therefore, this method allows for a broad range of opportunities for future research interested in capturing ambient audio in schizophrenia. For example, ambient audio may be used alongside measures of symptom severity and functioning to examine their associations with real-time word use. This may be particularly beneficial in ecological momentary assessment research, as particular words or speech patterns could serve as behavioral markers of in-the-

Table 1

Demographic characteristics and feasibility and acceptability survey items.

Characteristic mean (SD)	SZ (n = 20)	Controls (n = 15)	p
Age	53.30 (7.70)	43.33 (14.15)	.02
% male gender	75%	73%	.91
Years education	14.06 (3.02)	15.57 (3.20)	.22
Employment	29%	80%	<.01
% married/cohabitating	18%	1%	.35
% White/Caucasian	35%	60%	.16
% Hispanic/Latinx	6%	0%	.34
% Asian/Asian-American	35%	13%	.15
% Black/African-American	18%	20%	.87
% multiple ethnicities	6%	7%	.93
Feasibility and acceptability mean (SD)	SZ (n = 11)	Controls (n =10)	p
How difficult was it to use the program on the phone?	0.36 (0.51)	0.80 (1.32)	.07
How much did the prompts interfere with your daily activities?	0.30 (0.48)	1.20 (0.92)	.01
How uncomfortable did you feel answering the questions on the program on the phone?	0.45 (1.51)	0.40 (0.52)	.92
How much did you enjoy using the program on the phone?	3.27 (1.00)	2.70 (1.34)	.28
Would you be interested in participating in similar studies in the future? (% yes, n)	100 (11)	90 (9)	.28

Note. SD = standard deviation; SZ = schizophrenia. All participants reported their age and gender. There is missing data for all other demographics for three participants with schizophrenia.

moment fluctuations relating to clinical outcomes. Although our findings need to be replicated in larger samples throughout the schizophrenia spectrum, this study is an important step in demonstrating the feasibility and acceptability of measuring speech in daily life among people with schizophrenia.

Supplementary data to this article can be found online at https://doi.org/10.1016/j.schres.2020.12.007.

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