Reduced Idea Density in Speech as an Indicator of Schizophrenia and Ketamine Intoxication

Cati Brown  Michael A. Covington  James Semple  John Brown
University of Georgia  GlaxoSmithKline Plc

Contact: cati@uga.edu
Special thanks to Sara Weinstein (U. of British Columbia) for use of her speech data and to Congzhe He (U. of Georgia) for help with data analysis.

Overview

Idea density is the number of propositions expressed per 100 words (Kintsch 1974). Snowdon et al. (1996) found low idea density in written prose to be a strong predictor of Alzheimer’s disease in later life. In this study, we automate the measurement of idea density and show that low idea density in speech is correlated with schizophrenia and with subanesthetic doses of ketamine, which is thought to produce a cognitive impairment similar to schizophrenia.

An idea is a proposition that is anything that can be true or false. Thus “The brown dog barked in the garden” contains three propositions (dog was brown, dog was barked, it happened in the garden). Kintsch (1974) takes the number of propositional density (idea density) as a measure of text complexity.

Idea density corresponds closely to the ratio of verbs, adjectives, adverbs, prepositions, and conjunctions to the total number of words in a speech sample. Exploiting this fact, we developed a Computerized Idea Density Rater (CIDR), which estimates idea density through part-of-speech tagging.

We used CIDR to analyze two sets of volunteers’ descriptions of pictures from the Thematic Apperception Test. A between-groups comparison of schizophrenia and healthy controls revealed that patients’ speech tended to contain fewer idea density. In a place-controlled, double-blind, cross-over study of healthy volunteers given subanesthetic doses of ketamine, idea density was generally lower in the ketamine condition, even though disordered speech was not, in general, evident to the listener.

These results indicate that the automated measurement of idea density is potentially useful for the psychiatric diagnosis and accelerated drug development.

Idea Density in Ketamine Experiment

Expanding on place-controlled, double-blind experiment at Cambridge University, healthy volunteers were asked to describe three pictures from the Thematic Apperception Test (TAT). Murray 1943/1971 after two different administration of ketamine within 7 days.

Each volunteer was recorded on 3 occasions at least a week apart. Volunteers were unaware which they were receiving unless they felt the effects of the drug.

The experiment’s ‘low’ and ‘high’ dose were much smaller than the usual anesthetic dose, specifically:

Low dose: 0.08 mg/kg over 15 min + 0.04 mg/kg + 15 min
High dose: 0.2 mg/kg over 15 min + 0.1 mg/kg + 15 min

Doses were randomised, double blind, and the volunteers were not aware of the treatment.

Ketamine Experiment

Both ketaminized and schizophrenia were associated with significantly reduced idea density.

The ketaminized experiment yielded usable speech samples from 1 volunteer in the ketamine condition per drug.

Almost all of them stated with lower idea density with ketamine than with placebo even though the dose was too small that no effects on speech were audible to the untreated one. With the higher dose (still very low compared to anaesthetic doses), the reduction was highly significant (p < 0.001). The paired nature of the test (measuring each volunteer under 3 conditions) made it very sensitive.

The schizophrenia experiment was not on individually paired volunteers, and the results are somewhat less clear. Idea density is nevertheless lower in schizophrenia than in healthy controls (p < 0.05). The baseline showed although the means and range of idea density for the two groups were not far apart, the distributions were very different, a fact which should be explored with a larger sample.

Discussion

These results show that idea density of speech is a useful neuropsychological measure and that the approximate method used in CIDR is accurate enough to reliably show differences between ketamine-influenced speech, schizophrenic speech, and normal speech.

Further, these results show that the effect of ketamine on idea density is similar to the effect of schizophrenia - both cause a small but distinct decrease.

We have not yet explored whether these decreases are qualitatively different. In different situations a high or low idea density can mean different things, ranging from stimuli choices to discourse planning ability and limits on short-term memory.

Because of the ease of making the measurement, CIDR is a useful tool for exploring the psychology of speech.

What are ideas and idea density?

Idea density = number of ideas / number of words where idea (proposition) are whatever can be true or false

Examples:

- “the dog barked; it was near the garden”

Propositions:

1. Dog barked
2. Man heard dog
3. Man was close
4. Proposition 2 occurred in garden
5. Proposition 2 occurred at same time as (1)

Idea Density Decreases with Increasing Ketamine Dosage

Idea Density in Healthy vs. Schizophrenic Subjects

References


