
Uncovering Episodic Memory through Linguistic Measures in Schizophrenia

Katie Lewis Sean Murphy Yuko Hanakawa

Supplement to the poster presented at the annual convention of the **Association for Psychological Science**, San Francisco, California (2009).

Purpose

Episodic memory is memory for personal past events that are recalled with the vivid experience of psychologically traveling “back in time” and reliving the event (Tulving, 2002; Wheeler et al, 1997). It involves mentally locating the memory in a specific time and place and re-experiencing emotional and visceral responses that relate to the original event, as well as having the subjective experience of “being one’s self” within the event being recalled (also called “autonoetic awareness”) (Wheeler et al, 1997).

Previous research has indicated that patients diagnosed with schizophrenia often exhibit deficits of episodic memory (Danion et al, 2007; LePage et al, 2007), as well as more general impairments in autonoetic awareness (Neumann et al, 2007). The present study investigates whether episodic memory impairment can be detected using computerized linguistic measures that have been shown to measure access to nonverbal experiential material, and how this applies to the diagnosis of schizophrenia.

Background

Episodic memory impairment is commonly observed in schizophrenic patient populations. Danion (2007) suggested that inadequate cognitive processing of events in relation to the self occur at the time of encoding, resulting in an impaired sense of subjective time and an inability to retrieve memories with a sense of personal “consciousness.” This agrees with Wheeler’s (1997) proposal that the element of “time,” more than other contextual cues such as space, is the greatest contributor to a sensation of autonoesis during episodic retrieval. Dodd and Bucci (1987), in a sample of psychotic patients that included patients with schizophrenia, found that specific references to time, place and person, in that order, occurred less systematically and later in a personal narrative than in a non-clinical control group.

Orientation cues such as space and time are not only important for grounding a specific memory in a tangible reality, but have also been shown to have impaired neurological correlates in schizophrenia. Neuroimaging studies have found that episodic retrieval involves the specific reactivation of spatial and temporal processing areas in the brain (Ciaramelli et al, 2009; Hayes et al, 2004). Andreasen (2001) found that cognitive processing of both time and space information is severely impaired in schizophrenic patients, and that this in turn affects a

patient's capacity for "self"-consciousness. It is possible that a combination of an impaired sense of subjective time, along with an inability to effectively envisage a specific and vivid picture of the "where and when" of a personal memory, may contribute to the impairment of schizophrenic patients to retrieve episodic memory events.

If this is the case, we expect episodic impairment to be reflected linguistically in the narratives of personal memories of patients with schizophrenia. Bucci's (1995; 1997) concept of referential activity provides a measure of the connection between our verbal (symbolic) expressions and our nonverbal (symbolic imagistic) and subsymbolic experiences, including affect, somatic arousal, and perceptual imagery. Language that is high in referential activity indicates that the speaker is experiencing an increased level of engagement with poignant nonverbal sensations, and is able to communicate these experiences in such a way as to elicit a corresponding response in a listener. Given the close conceptual relationship of referential activity to the elements typically implicated in autoeic awareness and episodic memory retrieval (e.g. affective and somatic arousal), recent research has begun to explore the ability of computerized measures of referential activity to demonstrate episodic retrieval in memory narratives.

Bucci (1995) posits that language comes closest to capturing emotionally charged nonverbal experience when it is describing circumscribed episodes and specific images in a clear and concrete manner. By using language to recreate a vivid and imagistic world for a listener, the speaker is able to share their internal experience in a manner that clearly communicates an authentic emotional schema tied to a specific personally experienced event stored in memory.

In the present study we are interested in using this theoretical basis to investigate the relationship of referential activity and episodic memory in a sample of narratives collected from schizophrenic patients, with particular attention paid to the use of orientation words (related to motion, space and time) within these narratives. We expect that RA measures (both computerized WRAD and the manually-scored RA scales) will be positively correlated with use of orientation words, and that patients with schizophrenia will demonstrate lower levels on all measures compared to non-clinical control subjects.

Methods

Subjects

Subjects included 15 flat affect schizophrenic patients, 25 non-flat affect schizophrenic patients, and 17 non-clinical control participants. All subjects were male and matched for age and education level. Participants were not included in the study if they had an IQ below 80;

had evidence of any neurological disorders, toxic psychosis or seizure disorders; had been treated with ECT within the last six months; or if there was evidence of recent alcohol or substance abuse history.

Procedure

Identical semi-structured interviews with all subjects were conducted by Alpert et al (2000). Transcripts of the interviews were computer-scored using the Discourse Attribute Analysis Program (DAAP) and Weighted Referential Activity Dictionary (WRAD; both Bucci & Maskit, 2005) and manually-scored by judges for the four referential activity scales by Hanakawa (2004). Subjects were asked to report one happy and one sad memory, remembering who was present during each episode and what occurred before and afterward.

The transcribed speech samples were made available to the authors for additional computerized linguistic analysis using an updated version of DAAP and WRAD, and selected dictionaries from Pennebaker's Linguistic Inquiry and Word Count program (LIWC2007; Pennebaker et al, 2007).

Measures

Manually scored Referential Activity (RA), the Weighted Referential Activity Dictionary (WRAD) and the Discourse Attribute Analysis Program (DAAP)

The manually-scored referential activity measure is scored by reliable trained judges who rate text segments on four subscales, each scale ranging from 1 (low) to 10 (high). A score of *Concreteness* is determined by the presence of perceptual or sensory qualities within a text. *Specificity* is determined by the amount of detail and preciseness provided in the narrative. *Clarity* is scored on the extent to which a narrator shows consideration for an audience's ability to understand and follow their discourse; it is determined by both the clearness of focus of the narrative, as well as by the smoothness and logicity of transitions made within the text. Finally, *Imagery* is scored according to the effectiveness of the narrator in capturing and conveying emotional or imagistic experiences, especially vivid sensory impressions. An overall RA score is computed as the average of the four subscales (Bucci & Kabasakalian-McKay, 2004).

The WRAD consists of 696 words that have each been assigned a weight between 0 and +1, in degree of their relationship to referential activity. The weights were empirically derived using text segments that had been manually scored for RA (Bucci & Maskit, 2005).

Very generally speaking, words that carry a higher weight relate to specific or imagistic concepts or entities, while words carrying a lower weight are more general and abstract in nature. Several micro-dictionaries are included within the WRAD that identify qualities such as affective valence and disfluency (“like,” “umm,” etc). The WRAD correlates positively with the mean of the four manually-scored RA scales (*concreteness*, *clarity*, *specificity* and *imagery*) .40 - .60, and has an 85% coverage rate for clinically-related verbal material. The DAAP provides a smooth moving weighted average for referential activity dictionaries including the WRAD, and allows for a more refined overview of narrative flow than a literal word-by-word analysis.

Linguistic Inquiry and Word Count (LIWC2007)

The LIWC2007 is a large computerized linguistic analysis program based on a dictionary comprised of 4,500 words grouped into sub-dictionaries. The present study utilized the *Motion*, *Space*, and *Time* dictionaries from the LIWC2007, as well as the *Relativity* dictionary, which is a composite of the previous three. Most of the words in the *Relativity* dictionary were included not only for their objective properties, but also based on the recommendations of trained judges regarding their appropriateness to the category. The *Relativity* dictionary accounts for nearly 13% of spoken English in a general population (Pennebaker et al, 2007).

Results

Referential Activity Differs Significantly by Clinical Status

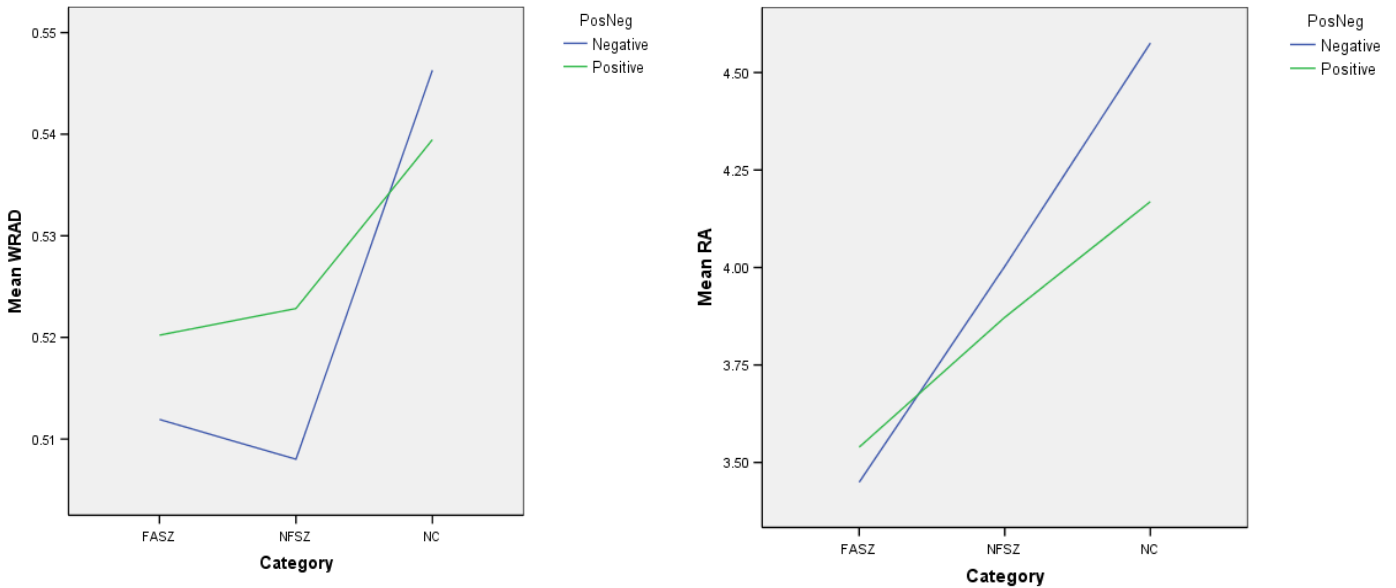
Referential activity measures were able to clearly distinguish between clinical and non-clinical groups, though not between the flat affect and non-flat affect patients in the clinical group. A repeated-measures MANOVA was conducted on the clinical group as a whole and the non-clinical group. Results showed that the clinical group had significantly lower scores on WRAD ($F=7.109$, $df=1$, $p=.010$), manually-scored RA ($F=6.423$, $df=1$, $p=.014$), and the *Clarity* ($F=7.15$, $df=1$, $p=.010$) and *Imagery* ($F=8.044$, $df=1$, $p=.006$) subscales.

	Mean WRAD*	WRAD SD	Mean RA**	RA SD
Clinical				
Positive Prompt	0.5219	0.041	3.674	1.164
Negative Prompt	0.5095	0.051	3.796	1.122
Non-clinical				
Positive Prompt	0.5395	0.033	4.191	0.839
Negative Prompt	0.5463	0.038	4.576	1.112

* WRAD measured on scale from 0.00 to 1.00

** RA measured on scale from 0 to 10.

Overall WRAD and RA Scale Scores, by prompt and group:



Orientation References Show a Consistent Positive Relationship to RA

Pennebaker's *Motion*, *Space*, *Time*, and *Relativity* dictionaries all showed a significant positive correlation to referential activity measures. *Relativity* was strongly correlated with both WRAD (Pearson = .482, $p=0.000$) and manually-scored RA (Pearson = .373, $p=0.000$). Pennebaker's *Space* dictionary showed the strongest relationship to referential activity of the three orientation types used, correlating .469 with WRAD and .410 with RA ($p=0.000$).

Correlations Between Referential Activity Measures and Orientation Measures

	Relativity	Motion	Space	Time
WRAD	.482**	.383**	.469**	.194**
RA	.373**	.257**	.410**	.132

** = $p < .05$

WRAD and RA Show Group Differences, Orientation Words Do Not

The repeated-measures MANOVA mentioned above revealed no group differences in orientation word usage during memory narration. The clinical subjects used a similar proportion of orientation words to the non-clinical subjects. Though RA differentiated the two groups, the relative proportion of orientation words did not. Though orientation words were moderately correlated with the RA measures contributing to the construct validity of the measure, the WRAD and RA measures seem to be picking up something different than the orientation measures alone.

Samples of High and Low RA Speech Used in the Present Study

High RA, Non-clinical Subject, Negative Prompt

“...that is easy. Obviously the worst thing I have gone through was in Vietnam. I suppose it was I had been in the hospital for what I thought was appendicitis and I had just gotten out of the hospital. I was back to my unit and my the same night I arrived back we were attacked in the middle of the night while I was asleep. I was the first one awake. I looked up to my tank and my sergeant was up there on guard duty and he yelled out it was incoming so having only my pants on I jumped up onto the tank and took the loaders position until the rest of the crew woke up. It was a pretty bad fire fight. it was the longest battle I had been in and we had a new a new fellow who arrived to take my place while I had been in the hospital and early in the evening I had noticed that the ammo box for the machine gun had been low and I asked him why he had not reloaded it and he said well I was going to do it in the morning and I mentioned what if we get attacked tonight and you know. He gave me a shrug. So I filled it up myself and sure enough we were attacked that night. It was rough going.”

Low RA, Clinical Subject, Positive Prompt

“Oh positive oh yeah okay oh yes. Oh well positive experience was when when mm (um) well when I was child they sent me up to pioneer camp and all that. And I used to work for the police and all that and mm (uh). I worked to I used to we used to work for the police department for a while. Then I had to get out of here because they were threatening to kill me and all that. I knew too many too many close encounters of the third nature. It was was in was in my way was in my way and mm (um) I thought I had to leave and everywhere I used to go I used to find trouble and people coming in for more looking for more trouble for me. And mm (um) I could not I could not I could not stay I could not stay. I could not stay you know in one place because I felt like I was being picked on. Only me. And and everybody else just friends and and you have everybody else against me everybody else will be against me I would feel that that everybody else was against me and they were just pushing me aside. Any any little thing that I used to do they used to complain and I used to come out fighting with somebody or another.”

Discussion

The present study reproduced the findings by Hanakawa (2004) that referential activity, as measured by WRAD, is significantly reduced in the narratives of schizophrenic patients when compared to non-clinical controls. The study also replicated Hanakawa’s findings using human scored RA measures. Additionally, we found high positive correlations between WRAD and LIWC2007’s *Motion*, *Space*, *Time* and *Relativity* dictionaries. To remove the possibility that this result occurred because of overlap with the same motion, space and time words in the WRAD dictionary, we compared orientation word usage from these dictionaries with human-scored referential activity measures (which are not based on a dictionary) and found the results were still significant in the predicted direction. This is meaningful for development of the RA construct, in supporting the conceptual relationship between orientation and the referential activity dimension, independent of measurement procedures. Additionally, while the WRAD alone was capable of distinguishing the clinical group from the controls, the *Motion*, *Space*,

Time and *Relativity* dictionaries alone did not differentiate between the clinical and non-clinical groups.

In light of our current findings and previous research on episodic memory and referential activity, we feel the results of this study provide support for the utilization of WRAD as a measure of episodic memory. WRAD has demonstrated ecological validity as an episodic memory measure by showing an ability to consistently differentiate between populations with known episodic deficits and non-clinical control groups (Nelson, 2009 - *accompanying poster*; Hanakawa, 2004), as well as strong construct validity in its relation to orientation word usage during memory narratives in the present study.

Episodic memory, more than other types of memory, requires an ability to conjure up clear mental images, and to allow relevant affective and visceral responses to be a part of the retrieval process. In an episodic narrative, this is expressed not only through relating a story within a contextual framework of orientation details, but also through evocative and vivid language use that adds a unique sensation of *in-the-moment* consciousness. Referential activity, as measured by WRAD, for the first time allows the opportunity to quantifiably measure the degree to which a recounted event is being accessed in this evocative and vivid way.

Limitations

This study was a preliminary analysis of the relationship between referential activity and episodic memory in a schizophrenic patient population. Results should be replicated using a larger sample and further studies conducted with additional populations known to have episodic impairment and other various memory deficits. The relationship of WRAD and RA to cognitive orientation processing should be explored using measures beyond Pennebaker's dictionaries, to further clarify the relationship of the two constructs.

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Please direct all questions and comments to Katie Lewis at lasracha13@hotmail.com. For further information, please visit www.referentialprocess.org