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## **Measures of Referential Activity As Indicators of Episodic Memory**

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### **Abstract**

This study compares two operational indicators of the psychological concept of episodic memory, one based on *Internal Details* that pertain directly to the main event described by the participant, and are specific to time and place, and the other based on the concept of *Referential Activity* that was developed in the context of multiple code theory, and that concerns the interconnections of nonverbal, including sensory, bodily and emotional experience to language. The measure of *Internal Details* depends on segmentation and rating by judges. Measurement of *Referential Activity* is carried out automatically using computerized procedures and pre-existing dictionaries.

### *Hypothesis*

To what extent do the two measures, derived from different psychological perspectives correspond? *We assume that the concept of episodic memory as defined by Tulving and his colleagues in terms of sense of subjective time, auto-noetic awareness and sense of self implies connection to sensory and emotional experience, as represented in the referential activity measure.*

### **Construct Definitions**

**Episodic Memory:** Knowledge of specific events as previously experienced, associated with *auto-noetic* awareness, *remembering* events in their specific context of time and place, in relation to the self.

**Semantic Memory:** General knowledge (may be verbal or imagery), associated with *noetic* awareness, the more general state of information retrieval characterized as *knowing*.

**Neuropsychological Differences Between Episodic and Semantic Memory:** Episodic narratives, told in the state of auto-noetic awareness, involve activation of the pre-frontal cortex with widely distributed cortical and subcortical networks including connections to hippocampus and amygdala. In contrast, the network of connections underlying semantic memory largely involves cortical zones. Information stored in semantic memory can be retrieved without hippocampal activation and without activation of emotional circuitry.

**The Construct of Referential Activity:** Referential activity in spontaneous speech, measured using judges' ratings and computerized measures, is related to other trait and state measures that indicate connection of nonverbal to verbal experience, such as:

- Rapid naming of colors<sup>[1,2]</sup>, objects, geometric forms<sup>[3]</sup>
- Use of hand movements linked to rhythm and intonation patterns of speech<sup>[1]</sup>
- Pattern and latency of orientation to time, place and person in spontaneous narrative speech<sup>[4]</sup>
- Variability of voice pitch.<sup>[5]</sup>
- Metaphoric style in experimental tasks<sup>[2]</sup>
- Event-specificity of personal memories, measured through temporal sequence in narration<sup>[6]</sup>
- Reports of core emotional and interpersonal themes, in interview and therapy contexts.<sup>[7,8,9]</sup>

RA fluctuates with stages of bipolar illness; high in hypomanic phase, low in depression<sup>[10]</sup>

RA is not related to measures of abstract verbal capacities such as the Vocabulary and Similarities subtests of the WAIS<sup>[1]</sup> or the Christensen-Guilford Fluency Test<sup>[1]</sup>

## **Participants and Procedures**

This study uses data collected by Addis, D.R., Wong, A.T. and Schacter, D.L.; as presented in their study: Age-Related Changes in the Episodic Simulation of Future Events; *Psychological Science*. (2008).<sup>[11]</sup> Levels of episodic memory were compared for younger and older adults and for past and future events. The data were provided by the authors for purposes of this study.

Participants: 16 young (mean age 25 years) and 16 older adults (mean age 72 years) with no history of neurological or psychiatric impairment.

Interview: Participants completed an adapted version of the Autobiographical Interview (AI) protocol (Levine et al., 2002)<sup>[12]</sup> that probed events in four conditions: Near Past (NP) – past few weeks; Far Past (FP) – past few years; Near Future (NF) – next few weeks; Far Future (FF) – next few years.

Scoring of Interview: Events generated in response to the first four randomly presented cue words in each condition were scored by Addis et al.<sup>[11]</sup> using the standardized AI scoring procedure developed by Levine et al. (2002)<sup>[12]</sup>. The same interview data were also scored for Referential Activity and other features of the referential process (Bucci and Maskit, 2005, 2007)<sup>[13,14]</sup> using the Discourse Attributes Analysis Program (Maskit & Bucci, web document).<sup>[15]</sup>

## Measures

### Referential Activity (RA)

RA was initially measured using ratings by judges on four scales: Concreteness, Clarity, Specificity, Imagery, based on Strunk and White's Rule 12,<sup>[16]</sup> and required segmentation by trained judges into "idea units."<sup>[17]</sup> A mathematical model of this scoring was developed by Bucci and Maskit<sup>[13]</sup>, which can be used in conjunction with a computer program in order to score text samples for RA. The dictionary currently in use is the Weighted Referential Activity Dictionary (WRAD) containing 696 highly frequent items, accounting for about 85% of spoken language (tokens). The dictionary is primarily used with the Discourse Attributes Analysis Program (DAAP)<sup>[15]</sup>, which uses smooth local weighted averaging to capture the ebb and flow of RA and similar variables.

In this study RA was assessed as High WRAD Proportion (HWP) – words in the high RA zone as a proportion of total words spoken. (This is the RA measure most comparable to the internal details ratio.)

### Autobiographical Interview Scoring Procedures

As carried out by Addis et al. (2008)<sup>[11]</sup>, the central event was identified first; if more than one event was mentioned, the event that was discussed in most detail and that occurred over a brief time frame was selected as the central event. The transcript was then segmented into distinct details or chunks of information and these details were categorized as internal or external. Inter-rater reliability was established on the basis of 20 events scored by three raters; the remaining events were scored by one of the three raters. For the current comparison, level of episodic memory was assessed for each event using a ratio of internal to total details (IntProp), following the procedure of Levine et al. (2002)<sup>[12]</sup>.

Internal details: pertain directly to the main event described by the participant, are specific to time and place, and are viewed as reflecting episodic re-experiencing.

External details: include semantic knowledge, factual information, extended events that did not require recollection of a specific time and place; also include repetitions, details pertaining to specific autobiographical events other than the main defined internal event and editorial and reflective statements.

## Results

Younger participants were higher in HWP than older ( $F=4.011$ ,  $df=1$ ,  $p=.047$ ), and HWP was higher for narratives of past than future events: Near Past vs. Near Future ( $p=.084$ ); Near Past vs. Far Future ( $p=.006$ ); Far Past vs. Near Future ( $p=.032$ ); Far Past vs. Far Future ( $p=.002$ ).

Younger participants showed higher levels of the internal details ratio than the older group; ( $F=55.143$ ,  $df=1$ ,  $p<.0001$ ). There was a trend for a time differential; the ratio was higher for narratives about events in the near past than for far future events ( $p=.062$ ).

## Comparison of Episodic Memory Measures

Fig. 1 All Subjects

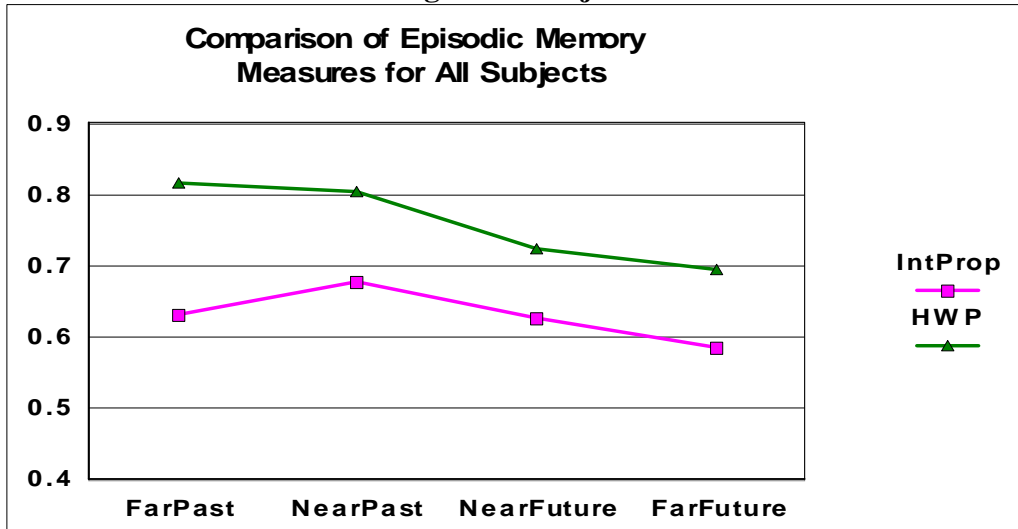


Fig. 2 Younger Subjects

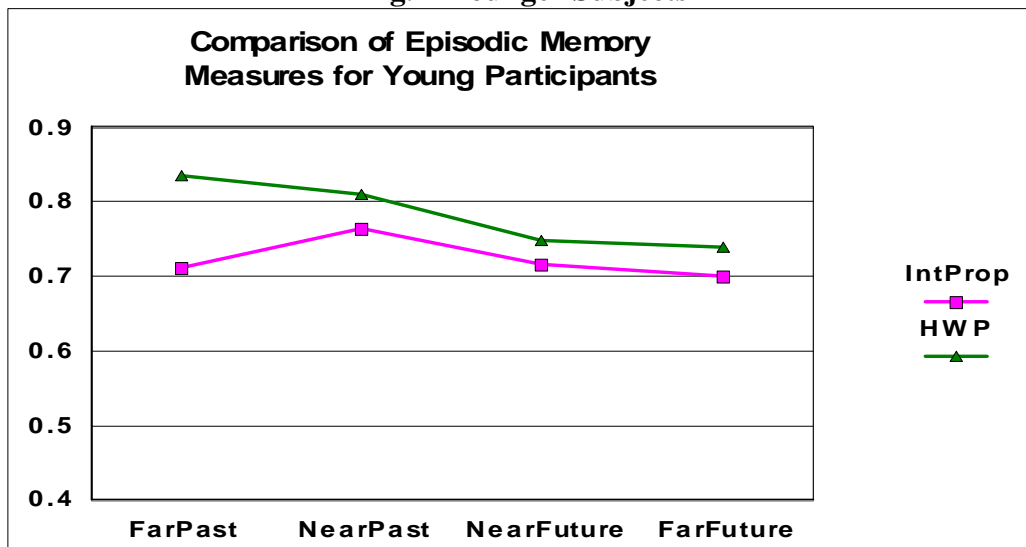
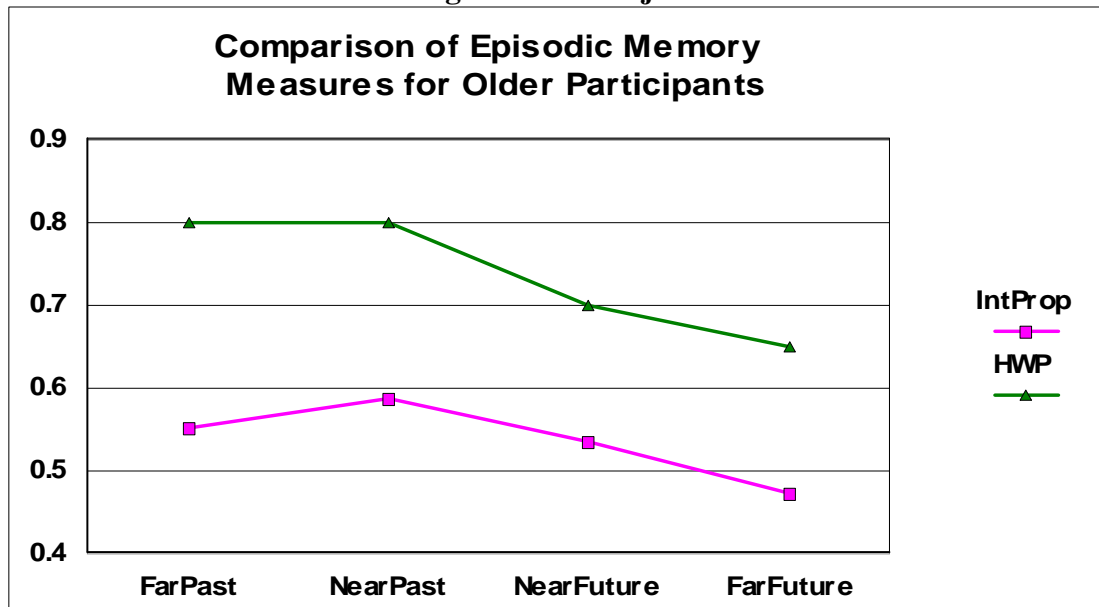


Fig. 3 Older Subjects



**Pearson Correlations of High WRAD Proportion with Proportion of Internal Details**

Age Group	Time of Event				
	Far Past	Near Past	Near Future	Far Future	Total, All Times
Younger	0.072	0.038	0.572	0.712	0.437
Older	0.139	0.588	0.471	0.598	0.504
Total, All Participants	0.178	0.268	0.515	0.670	0.478

**EXAMPLES (Internal details in red)**

**Example 1: Far Past, HWP=1 (High); IntProp=.367 (Low)**

Few months ago, I went to a party at a friend's house and we were playing this game where everybody brings a gift or something they don't want and end up having something different than they brought in. My friend brought extra gifts just in case people forgot to bring their gifts and so afterwards, and - this party and everyone else had left but I was sleeping over because she lives far away, she asked me if I wanted some of the leftover gifts and one of the gifts was a tea kettle, not the kind you put on the stove, but the kind where you have already boiled the water and put in it and pour out, so I took the tea kettle home with me and it's pretty, turquoise color but I decided I didn't really want it and what I did was give it to my other friend as a birthday present - the tea kettle kind of looked

like it was made somewhere in Asia, she was having her birthday dinner at an Asian restaurant so I thought it'd go well with the theme so I wrapped up the tea kettle, it had never been used, it's all shrink wrapped and I wrapped it up with tissue paper and put it in a little shopping bag - and she's very excited about the tea kettle when she opened it - and I'm glad I gave it to her because I didn't think I was going to use it and she seemed to like it a lot and - she - said that she had been looking at tea kettles lately and kind of wanted one and I said remember we've been to that store that sells tea and we were looking at them and - - so - I figured that she was probably going to use it. It was very cold that day, so maybe she used it to make tea when she got home - - and I gave her a tea kettle and someone else gave her a CD I think

**Example 2: Far Past, HWP=1 (High); IntProp=.433 (Low);**

When I was living in the dorms in Santa Barbara, UCSB, we had a mouse - that was living, he was going through the room but he was living in the heater, the heater vent in the bottom of the room and he likes to come in and eat my underwear - bizarre, he ate 11 pairs of my underwear - for some reason, he just loves underwear so my roommate would start storing her clothes, hanging there so he couldn't get up although I think he did at one point, crawled up there but - I just remember, I remember because I had my bed mid-level, about this high so I had my laundry basket under my bed - and he would come in, right near where the head of my bed was and - never saw him but he'd chewed - all my underwear and so we set up these sticky traps

Interviewer: Are you thinking of one particular incident?

Where he was in the sticky traps so we put the sticky traps under my bed and - so we put it out one night and the next morning, I looked down and I found this sticky trap, he wasn't in it but - he had, hair was stuck in it and there was blood in it and like poop so I guess he got stuck in the sticky trap, he dragged himself out of it, using the heater grate, ripped his body out of the sticky trap and left behind quite a lot of tissue - very disgusting and he got away and he kept coming but I just remember that morning - he had the sticky trap, we called him Hercules after that - bizarre so weird, so that's the story of my laundry attire - I hate those sticky traps

**Example 3: Near Past, HWP=.41 (Low); IntProp=.75 (High)**

Oh, so I guess I was reading . . . I use the drug report to get a lot of articles online, like news articles. And I, this was yesterday, and one of the headlines was that two days ago, Hugo Chavez, the Venezuelan President, called George Bush "the devil" at the UN Security Council and people kinda got riled up about it ...so that was (mumbling) Friday ...but then ..so he just sort of trashed Bush in the speech and then some of the Democrats, actually some of Bush's strongest opponents, came out in Bush's defense, and I was really surprised by that. I know Nancy Pelosi was one of them and I think Harry Reed was the other. So they basically said whatever internal differences we have in our country, and disagreements with our President, you just can't come on our soil and say that, I mean that's totally unbecoming of the Head of State and I was actually sort of relieved to hear that because there's so much of this partisan nonsense about you know, Bush's destroyed democracy, and the whatnot, I think most of that is pretty childish.

Interviewer: So you are thinking about when you read this?

The...yeah. So the Republicans have their childishness too, but in this particular case, the ...I was really happy to see that some of these prominent Democrats actually be fairly reasonable

## **Discussion**

The overall correlation of .478 between WRAD and IntProp provides evidence that our computerized assessment of referential activity can be used as an indicator of episodic memory and so can reduce the need for judges' ratings in large sample studies.

### **Differences between RA and Internal Detail Scoring**

- Some younger participants show considerably more tendency to associate freely to related memories when reporting past events than when generating future ones, as indicated by high RA.
- This applies particularly to associations related emotionally but extended in time, in both far past and near past events.
- Conversely, some younger participants talk about past experiences in a neutral mode, and are more able to access personal experience in focused rather than associative form in future fantasy. (We are exploring a gender difference in this effect.)
- Older participants show more discrepancy of overall level of the two measures for all time periods.
- Older participants show lack of correlation between the two measures only for far past events.

### **Some Qualities of RA Scoring that Account for Differences with Counts of Internal Details**

- RA scoring depends on linguistic features that emerge unintentionally when speakers are immersed in the narrative symbolizing mode. Whether telling a past event or generating a future one they will implicitly apply the particular linguistic mechanisms of story telling without directing the choice of these syntactic structures.
- Therefore RA scoring does not differentiate between the single main event and events associated emotionally in memory, and also does not eliminate repetitions used for emphasis.
- It is possible that the unintentional linguistic features are more effective than reliance on a specific time frame in representing the degree to which a speaker is re-experiencing the emotional aspects of the event in relation to the self.

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