<table>
<thead>
<tr>
<th>Name (Last, First, Middle)</th>
<th>Adler, Ira R.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degree title (e.g. BA, BS, BSE, BSB, BFA):</td>
<td>B.A.</td>
</tr>
<tr>
<td>Honors area (e.g. Molecular and Cellular Biology, English, Studio Art):</td>
<td>Psychology</td>
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<tr>
<td>Date thesis submitted to Honors College:</td>
<td>December 2012</td>
</tr>
<tr>
<td>Title of Honors thesis:</td>
<td>What's In Self-Referential Imagining?</td>
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Last updated: Nov 15, 2009
What's In Self-Referential Imagining?

By

Ira R. Adler

A Thesis Submitted to the Honors College

In Partial Fulfillment of the Bachelors degree
With Honors in
Psychology (B.A.)

THE UNIVERSITY OF ARIZONA
DECEMBER 2012

Approved by:

Dr. Elizabeth Glisky
Department of Psychology University of Arizona
STATEMENT BY AUTHOR

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Self-Referential Imagining
ACKNOWLEDGMENTS

My appreciation goes to Dr. Elizabeth Glisky and Dr. Matthew Grilli for their superior mentorship during my thesis project. Also, I could not have completed this project without the on-going support of lab manager, Cindy Woolverton, and the assistance and guidance of graduate students Angelina Polsinelli, Janelle Wohltmann and Molly Bisbee. Finally, I thank research assistants Carrie Edwards for her dedication in scoring, Tomas Martinez and Erica Selenkow for their assistance with transcription, and Tamara Clause for her help in data processing.
Abstract

The combination of memory-enhancing processes of imagining and of self-reference has been shown to improve memory function, the Self-Imagining Effect (SIE), in healthy subjects and in persons with neurological damage resulting from traumatic brain injury (TBI). Prior studies have instructed participants to “imagine yourself” but have not confirmed that self-referential information is being accessed in self-imagining. The current study investigated the content of self-referential imagining which may mediate the SIE advantage. Participants, both healthy persons and persons who had sustained a traumatic brain injury (TBI) and suffer memory impairment, were instructed to imagine themselves and an “other-person” interacting with various objects and to simultaneously describe their imaginings. The recorded imaginings were scored for descriptive (location, agent, event and perception/emotion) and referential (self, other specific, and general) elements. Findings suggest that self-imagining does access self-referential information and is more content-rich than other-person imagining. The elements found in self-imagining were representative of episodic-like information. Other-person imagining, while not as content-rich, contained proportionately similar descriptive elements. The study provides a better understanding of the salient features of self-imagining and may elucidate the role of self-referential knowledge in mnemonic strategies in persons with neurological damage due to TBI.
Self-Referential Imagining

What's In Self-Referential Imagining?

Memory rehabilitation strategies applied to persons with neurological damage resulting from traumatic brain injury (TBI) have focused on compensating for the impaired functioning of the injured neural substrates (Wilson, 2009). Compensations using external devices which provide visual and/or auditory cues, such as personal data assistants, alarms, post-it notes and environmental changes have proven effective. However, these techniques are often complicated and therefore require a great deal of learning, which is particularly difficult for persons who have sustained a TBI. In response, learning techniques have been developed, such as Errorless Learning (Baddeley & Wilson, 1994) and Vanishing Cues (Glisky & Schacter, 1988), which tap into implicit memory processes, and have proven effective in children with developmental learning difficulties as well as persons with neurological damage. These methods are often effortful and time consuming. However, they target intact cognitive processes avoiding damaged neural substrates which are likely not recoverable. Siedlecki & Stern (2009) suggested that, following TBI, cognitive reserve, which accesses neural reserve and neural compensation, i.e., plasticity, may help to overcome cognitive sequelae of brain injury.

Earlier studies have suggested that access to self-referential knowledge provides an advantage in memory tasks, the Self Reference Effect (SRE) (Rogers, Kuiper & Kirker, 1977). Associating information to a person or the self may be crucial to recollection (Conway, 2005). Klein & Lax (2010) found that self-knowledge is often intact in persons with neurological damage despite other cognitive impairments in executive functions and memory. Self-knowledge includes a sense of one’s own personality traits and semantic knowledge of oneself. Episodic memory, memory for personal events, however, has been found more likely to be
impaired in persons with neurological damage. Therefore, Klein & Lax (2010) posited that there might be a unique cognitive mechanism in self-knowledge, which may be preserved in many memory-impaired patients with acquired brain injury. Recent fMRI studies seem to indicate that the cortical midline structures including medial prefrontal cortex (mPFC) are associated with self-referential processing as well as emotional and social processing (Gillihan & Farah, 2005).

Research has shown that self-referential processing as well as imagining, i.e., visual imagery, are effective mnemonic strategies. This mnemonic advantage has been seen in persons both with and without neurological damage from TBI. There is additional evidence that self-referential imagining, i.e., imagining which incorporates the self in the production of the specific imagined event, improves memory in healthy individuals as well as memory-impaired individuals with neurological damage. This improvement has been labeled the “Self-Imagination Effect” (SIE) by Grilli & Glisky (2010). The SIE has been shown to improve memory functioning better than semantic elaboration, emotional processing, and other-person encoding. Recognition memory, prospective memory (memory for tasks to be performed in the future), cued-recall, and free recall memory have all been shown to improve following encoding tasks involving self-imagining. These results have been seen in both healthy and neurologically damaged participants (Grilli & Glisky, 2010, Grilli & Glisky, 2011, Grilli & Glisky, 2012, Grilli & McFarland, 2011). Grilli and Glisky propose that there may be three reasons for the self-imagining advantage: “…1) self-imagining may tap into self-referential processing, 2) self-imagining may be attributable to intact mnemonic mechanisms, and 3) self-knowledge appears to be relatively well preserved in memory-impaired individuals in comparison to episodic memory.” (Grilli & Glisky, 2010) In another study, Grilli and Glisky (2012) found that both episodic and semantic self-knowledge mediated mnemonic advantages in healthy controls while,
in persons with neurological damage resulting from TBI, the effects were dependent primarily on semantic self-knowledge. They suggested that this was related to the greater impairment of episodic memory than semantic memory in persons who have suffered a TBI.

To our knowledge, prior research has not investigated what content of self-imaginings may be most important to success in memory retrieval tasks and whether the nature of such content is different in memory-impaired individuals from those without impairments. However, the content of self-imaginings has been investigated in the context of imagining new experiences (Hassabis, Kumaran, Vann & Maguire, 2007). In their study, Hassabis and colleagues tested healthy controls (n=10) and patients with amnesia of various etiologies resulting in bi-lateral hippocampal damage (n=10). Using verbal cues of commonplace scenarios, they instructed the participants to imagine themselves in the scenario. The participants were further instructed explicitly not to relate a memory or part of a memory, but to form a new experience using visual imagery. The participants described their imaginings and the descriptions were scored on information content (sensory descriptions, spatial references, number of entities present (persons, animals, objects), and thoughts/emotions/actions). Combining the ratings of information content with both participant feedback regarding the strength of feeling of vividness of the imaginings and researcher ratings of the quality of the imaginings, Hassabis et al found that the participants with hippocampal damage were unable to form as rich imaginings for future experiences as were the healthy subjects.

The current study investigated the contextual aspects of self-referential and other-person imagining. I hypothesized that, in both healthy subjects and persons with neurological damage resulting from traumatic brain injury, self-referential imagining would provide more detailed and vivid content than other-person imaginings and that the features of such content would predict
later memory retrieval in a word recognition test. The principal aim of the proposed study was to investigate the content-richness of self-imagining as compared to other-person imagining and to determine if one component of such content is more predictive than other features of mnemonic success in both groups of participants.

**Method**

**Participants**

Participants were drawn from two populations. Healthy participants (n = 16), who self-reported that they had no history of neurological damage nor neurological dysfunction, were enlisted from introductory psychology classes at the University of Arizona. In addition, four other healthy individuals were tested but excluded from the study due to language barriers.

Four individuals with neurological damage resulting from TBI participated in the study. Three were recruited from those previously identified in the Aging and Cognition lab of Dr. Elizabeth Glisky at the University of Arizona and one was identified as an undergraduate student attending the University of Arizona. The non-student participants with neurological damage were identified from TBI support groups in Tucson, Arizona, and tested using a battery of neurological measures, including the general memory index (GMI) of the Wechsler Memory Scale (WMS-III; Wechsler, 1997). All participants with neurological damage were eligible for inclusion in the study if they had sustained TBI at least 18 months prior to testing, exhibited memory impairment (defined as a GMI score of at least 1 standard deviation (i.e., 15 points) below the pre-morbid IQ (NAART; Spreen & Strauss, 1998), and were cognitively stable. One individual with neurological damage was tested but excluded due to having suffered a seizure immediately prior to testing.

The demographics of the participant groups are shown in Table 1.
Table 1: Participant Demographics

<table>
<thead>
<tr>
<th>Group</th>
<th>Participants (n=)</th>
<th>Age</th>
<th>Years of Education</th>
<th>Sex</th>
<th>Ethnicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controls</td>
<td>16</td>
<td>Mean 21.6</td>
<td>14.2</td>
<td>Female 15</td>
<td>Caucasian 10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Range 18-33</td>
<td>12-18</td>
<td>Male 1</td>
<td>Hispanic 2</td>
</tr>
<tr>
<td>Persons with neurological damage</td>
<td>4</td>
<td>Mean 46</td>
<td>15.5</td>
<td>Female 2</td>
<td>Caucasian 3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Range 24-58</td>
<td>14-18</td>
<td>Male 2</td>
<td>Hispanic 0</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Black 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Other 0</td>
</tr>
</tbody>
</table>

Materials

Experimental stimuli consisted of 64 words for common objects selected on the basis of frequency of usage in English language speakers, concreteness and imageability. The selections were made from lists generated from the MRC Psycholinguistic Database Version II (Coltheart, 1981). The words selected had a mean frequency measure (scale: 0-6833, mean=35) of 14.1, a mean concreteness measure (scale: 100-700, mean=438) of 598.2 and a mean imageability measure (scale: 100-700, mean=450) of 597.1. The word-objects were segregated into three blocks, two of 16 words each (Blocks A and B) and a third block of 32 (novel). Words were randomly mixed within their blocks during encoding and within all three blocks together during the test phase and presented visually to healthy participants on an in-lab computer and to persons with memory impairment on an HP laptop computer. Both computers presented stimuli using the DMASTR DirectX program (DMDX: Forster & Forster, 2003).
Procedures

Written consent of each of the participants was provided prior to taking part in the study. All data collection was made in compliance with regulations of the University of Arizona Institutional Review Board.

Participants were instructed to complete a brief “health” questionnaire which inquired as to the participant’s age, education, medications currently being taken, history of neurological damage and/or alcohol/substance usage, if any.

The study procedures included two encoding tasks blocked by condition and a single word recognition test. In one encoding task, participants were instructed to “Imagine yourself interacting or doing something with [word stimulus]” (the “self-imagining” condition), and, in the other encoding task, they were asked to “Imagine the movie star interacting or doing something with [word stimulus]” (the “other-person imagining” condition). Each participant was shown an example of an imagining reflecting the requested condition and given two practice trials to ensure that the instructions were understood. If the other-person encoding condition was to be imagined, the participant was asked to identify one movie star of their choosing and to use that one movie star in each trial under that condition. The participants were instructed to describe their imaginings out loud and each imagining was recorded using a Sony MP3 digital recorder. Following completion of the imaginings in the first encoding condition, a brief (not to exceed 5 minutes) distracter (i.e., a small 8x8 letter word search puzzle consisting of non-object words) was completed by each participant. Immediately following the distracter task, the alternate encoding condition was presented. In each encoding condition, a total of 20 words was presented, which included two primacy buffers and two recency buffers. Each imagining trial
was limited to 30 seconds, after which the next word would appear on the screen. Each word was shown on the computer screen for five of the 30 seconds. Block A and Block B stimuli were counterbalanced across the encoding conditions and the order of the encoding conditions was counterbalanced across participants.

Following the encoding tasks, healthy controls were instructed to leave and told to return for a second session approximately 24 hours after the start of the first session for a short second session. The second session for the control group consisted of a word recognition test described below. Following the encoding tasks by persons with neurological damage, they were presented a computerized trivia game as a second distracter task. The trivia game, which consisted of questions regarding geography, history, literature, and pop culture, either continued to completion or was terminated 30 minutes following the end of the second condition encoding task. The word recognition test was administered to these participants immediately after the second distracter task.

The word recognition test consisted of the 64 words included in Block A, Block B and 32 novel words. Each word was presented on the computer screen and participants were asked to press “Y” for “Yes” if they had imagined either themselves or the movie star interacting with the stimuli during the encoding phases or to press “N” for “No” if they had not imagined either themselves or the movie star interacting with the stimuli. Each word was presented until the participant selected either “Y” or “N” on the computer’s keyboard.

After the recognition test was completed by the participant, each participant was given an oral debriefing by the researcher.
**Data Analysis**

The recorded imaginings were transcribed by either the researcher or a research assistant. The transcribed imaginings of 8 participants were scored by a different research assistant and 12 by the researcher. The content of the transcribed imaginings was classified for 13 characteristics that reflected either self-referential content (specific to the participant), other specific content (referring to other persons or objects), and semantic components (general, non-specific content). The persons who classified the content of the transcripts were extensively trained prior to scoring study transcripts in order to assess interrater reliability. Transcripts used in training were from piloting studies. Across categories, raters agreed on 80% or more the content features during training.

Categorizing of the data consisted of identifying different elements of the transcribed imaginings. Location information was scored as Location – Personal, Location-Other Specific or Location-General. Agent information was scored as Agent-Personal, Agent-Other Specific or Agent-General. Event type was scored as Event-Specific, Event-General, or Event-Other. References to Emotion and Perceptual Details comprised the remaining two categories of content. Descriptions and characteristic examples of each category are contained in Appendix 1. Following the classification of the content of the transcribed imaginings, the number of references in each category for each of the stimuli was recorded.

Four indices of the descriptive nature of the content of the imaginings were calculated as follows: The Location Index (LI) is the percentage calculated by dividing the sum of elements in each imagining classified as Location-Personal, Location-Other Specific, and Location-General by the total number of classified elements in that imagining. The Agent Index (AI) is the percentage calculated by dividing the sum of Agent-Personal, Agent-Other Specific, and Agent-
General elements by the total number of elements in each imagining. The Event Index (EI) is the percentage calculated by dividing the sum of elements classified as Event-Specific, Event-General, and Event-Other by the total number of classified elements in each imagining. The fourth index, the Perception/Emotion Index (PEI), calculated the combined number of elements classified as Emotion and Perceptual Details, divided by the total number of references in each imagining.

Three indices of the referential nature of the content of the imaginings were calculated as follows: The Self-Reference Index (SRI) is the percentage calculated by dividing the sum of elements within each imagining scored as Location-Personal, Agent-Personal, and Event-Specific by the total number of elements in each imagining. The SRI is intended to represent a measure of the most salient features of self-reference in the imaginings. The Other-Specific Index (OSI) is the percentage calculated by dividing the sum of elements within each imagining scored as Location-Other Specific, Agent-Other Specific, and Event-General by the total number of elements in each imagining. The OSI represents a measure of content concerning other specifically identified (by name), but non-self, entities. The third index, the Semantic Index (SI) is calculated by dividing the sum of references within each imagining classified as Location-General, Agent-General and Event-Other classifications by the total number of references found in each imagining. The SI measures the generalized, semantic-type content within each imagining trial. The content scored as Perception/Emotion was excluded from the calculations of reference indices as attribution to a referential category was difficult to assess. The data were then analyzed in separate 2 (self vs. other-person) x 2 (memory impaired vs. healthy controls) mixed ANOVAs.
Results

Effect of Encoding Condition on Descriptive Characteristics

Table 2 contains the data for the number of scored elements segregated by encoding condition and by study group.

TABLE 2: Means for Self-Imagining and Other-Person Imagining by Group

<table>
<thead>
<tr>
<th>Descriptive Content</th>
<th>Healthy Controls (n=16)</th>
<th>Memory Impaired (n=4)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Self</td>
<td>Other-Person</td>
</tr>
<tr>
<td>Location</td>
<td>30.8 (11.8)</td>
<td>31.2 (8.5)</td>
</tr>
<tr>
<td>Agent</td>
<td>132.1 (34.6)</td>
<td>95.2 (32.6)</td>
</tr>
<tr>
<td>Event</td>
<td>133.6 (35.0)</td>
<td>117.2 (37.5)</td>
</tr>
<tr>
<td>Perception/Emotion</td>
<td>64.3 (18.7)</td>
<td>50.2 (21.8)</td>
</tr>
<tr>
<td>Total Content</td>
<td>360.8 (90.6)</td>
<td>293.8 (85.5)</td>
</tr>
</tbody>
</table>

Standard deviations shown in parentheses.

The first 2x2 ANOVA analyzed the total number of scored elements in the imaginings. There was a significant main effect of condition, $F(1,18)=25.809, p<.001, \eta^2=.589$; more elements were found in self-imaginings (mean=326.6, s.d.=26.8) than in other-person imaginings (mean=258.4, s.d.=23.9). These data demonstrate that self-imaginings are richer in content (more scored elements) than other-person imaginings. There was no significant main effect of group despite a large difference in the total number of scored elements in the imaginings of healthy controls (mean=327.3, s.d.=21.9) compared to the total number of scored elements in the imaginings of individuals with memory impairment (mean=257.8, s.d.=43.7). That this difference was not found to be significant may be due to the small number of participants in the memory impaired group and the resulting high standard deviation. There was also no significant interaction demonstrated, i.e., in both groups studied there were more elements of content found in self-imaginings than in other-person imaginings, and persons with
memory impairment produced fewer elements compared to healthy controls in both self-imagineings and other-person imaginings.

No significant main effect of condition was found in the 2x2 ANOVAs of Location content of the imaginings, $F(1,18) < 1.0$ in each analysis.

In the 2x2 ANOVA of the number of elements scored as Agent content, a significant main effect of condition was found, $F(1,18) = 20.610$, $p < .001$, $\eta^2 = 0.534$. The number of Agent elements found in self-imagineings (mean=117.8, s.d.=11.2) was greater than found in other-person imagineings (mean=84.2, s.d.=9.1).

Event-related content demonstrated a significant main effect of condition, $F(1,18) = 16.454$, $p = .001$, $\eta^2 = 0.478$. Event content was greater in the self-imagineing condition (mean=123.2, s.d.=9.7) than in the other-person imagineing condition (mean=101.2, s.d.=10.2).

Self-imagineings contained significantly more scored elements of a Perception/Emotion character. There was a significant main effect of condition, $F(1,18) = 8.471$, $p < 0.01$, $\eta^2 = 0.320$. Perception/Emotion scored content in self-imagineings (mean=55.3, s.d.=5.5) was greater than in other-person imagineings (mean=42.7, s.d.=6.2).

No main effects of group and no interactions were found to be significant in any of the analyses of the individual components of descriptive content.

As shown above, the data from the imagineings supports the hypothesis that the content of self-imagineings is richer (more elements) and more vivid (more elements in each scored descriptive category) than the content of other-person imagineings.

**Effect of Encoding Condition on Proportion of Descriptive and Referential Content**

Table 3 contains the data for the proportion of scored descriptive elements, aggregated by category, to total elements segregated by encoding condition and by study group.
Descriptive Indices. The 2x2 ANOVA of Location Index demonstrated a significant main effect of condition, $F(1,18)=7.956$, $p<.05$, $\eta^2=0.307$. Location Index was lower in self-imagining (mean=10.4%, s.d.=1.1%) than in other-person imagining (mean=12.8%, s.d.=1.2%).

No significant main effects of condition and of group and no interactions were found in the Agent and Perception/Emotion indices data.

TABLE 3: Mean Descriptive and Reference Indices by Group; Percent of Total Content

<table>
<thead>
<tr>
<th></th>
<th>Healthy Controls (n=16)</th>
<th>Memory Impaired (n=4)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Self</td>
<td>Other-Person</td>
</tr>
<tr>
<td>Location Index</td>
<td>8.7 (3.1)</td>
<td>11.4 (4.3)</td>
</tr>
<tr>
<td>Agent Index</td>
<td>36.6 (2.2)</td>
<td>32.2 (3.2)</td>
</tr>
<tr>
<td>Event Index</td>
<td>36.9 (2.2)</td>
<td>39.7 (3.4)</td>
</tr>
<tr>
<td>Perception/Emotion Index</td>
<td>17.8 (3.0)</td>
<td>16.8 (3.9)</td>
</tr>
<tr>
<td>Self-Reference Index</td>
<td>41.5 (9.7)</td>
<td>0.5 (1.0)</td>
</tr>
<tr>
<td>Other-Specific Index</td>
<td>11.8 (3.9)</td>
<td>48.3 (6.4)</td>
</tr>
<tr>
<td>Semantic Index</td>
<td>29.1 (6.8)</td>
<td>34.4 (6.2)</td>
</tr>
</tbody>
</table>

* Excluding content scored as Perception and Emotion

Note: Standard deviations shown in parentheses.

The 2x2 ANOVA of Event Index data, which also did not demonstrate main effects of condition and of group, did demonstrate a significant interaction, $F(1,18)=5.312$, $p<0.05$, $\eta^2=0.228$. In healthy controls, the proportion of total content devoted to Event-related content was lower (mean=36.9%, s.d.=1.0%) in the self-imaginings than in the other-person imaginings (mean=39.7%, s.d.=0.8%). The proportion of total content devoted to Event-related content was higher (mean=41.0%, s.d.=2.0%) in the self-imaginings of persons with memory impairment than in their other-person imaginings (mean=38.7%, s.d.=1.6%). However, in t-tests, these differences were found to be not significant.
The analyses of the Descriptive Indices indicates that, although self-imagining is more content rich than other-person imagining (see *Effect of Encoding Condition on Descriptive Characteristics* above), the proportion of the different types of descriptive content is similar in both conditions and in both groups.

**Reference Indices.** As indicated by the Self-Reference Index (SRI), elements of imaginings which suggest access to self-representations made up a significantly higher proportion of total scored elements in the self-imagining condition than in the other-person imagining condition. A significant main effect of condition was demonstrated, $F(1,19)=148.487$, $p<.001$, $\eta^2=.892$. As hypothesized, participants made significantly more references to themselves, personally identifiable locations, and self-related actions proportionately in the self-imagining condition (mean=43.6%, s.d.=3.0%) than in the other-person imagining condition (mean=2.0%, s.d.=0.7%).

Contrasted to the SRI, the Other Specific Index (OSI), which represents the proportion of non-self-referential content to total content, also showed a significant main effect of condition, $F(1,18)=228.893$, $p<.001$, $\eta^2=0.927$. As expected, participants made a higher proportion of Other Specific references to the total of scored elements in imaginings in the other-person imagining condition (mean=49.6%, s.d.=1.9%) than in the self-imagining condition (mean=12.2%, s.d.=1.3%).

The proportion of scored elements considered general, i.e., neither self-referential nor other-specific referential, to total scored elements also showed a significant main effect of condition, $F(1,18)=6.188$, $p<0.05$, $\eta^2 = 0.256$. The Semantic Index (SI) evidenced proportionately more general elements in other-person imaginings (mean=32.5%, s.d.=1.6%) than in self-imaginings (mean=28.0%, s.d.=1.8%).
There were no significant effects of group and no interactions demonstrated in the referential indices data. However, these data support the finding that the content of imaginings contained more self-referential information in the self-imagining condition than in the other-person imagining condition.

**Effect of Encoding Condition on Memory**

A 2x2 ANOVA was used to analyze the effect of encoding condition on recognition memory. The analysis did not demonstrate a significant main effect of condition, group or interaction. The hypotheses that the self-imagining condition would produce a higher rate of correctly recognized words compared to other-person imagining and that both healthy controls and memory-impaired persons would benefit from the self-imagining elaboration strategy compared to other-person imagining elaboration were not confirmed. See Table 4.

**TABLE 4: Mean Corrected Recognition by Group**

<table>
<thead>
<tr>
<th></th>
<th>Healthy Controls (n=16)</th>
<th>Memory Impaired (n=4)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Self</td>
<td>Other-Person</td>
</tr>
<tr>
<td>Corrected Recognition</td>
<td>10.7 (2.4)</td>
<td>11.9 (2.3)</td>
</tr>
</tbody>
</table>

Note: standard deviations shown in parentheses.

**Discussion**

This study sought to pry open self-imagining and the effect of self-reference on memory function by looking into the content of self-imaginings. We analyzed various elements of self-imagining and of other-person imagining to test our hypotheses that (1) self-referential imaginings contain more detailed and vivid content than other-person imaginings, and (2) the self-referential features of such content would predict later memory retrieval in a word
recognition test, explaining, in part, the advantage of combining self-reference and visual imagination, the SIE.

The findings indicate that self-referential information is indeed being accessed in self-imagining and to a greater extent in self-imagining than in other-person imagining. Semantic elaboration, i.e., references both to other-specific and general information, was found to be more prevalent than self-referential information in other-person imagining. This supports the first hypothesis. The study shows self-imagining is more content-rich than other-person imagining. In each of the descriptive classifications and in total, self-imagining produced more descriptive elements than other-person imagining. However, proportionate to the number of elements in each imagining, descriptive elements were relatively consistently represented. Self-imagining clearly contained more episodic-like references (what, where, when and who), more detailed imagery, and, proportionately, more self-referential elements. Other-person imaginings, which accessed knowledge of the participant’s self-selected movie star, were also vivid and detailed, although they lacked the self-referential richness of self-imaginings. This may suggest that “person” schema, either of oneself or of another person familiar to the participant either personally or through exposure to media, may mediate the degree of contextual richness in imagining.

While it was our intuition that spatial, agent, event and perception/emotion content may be found more frequently in self-imaginings, this was not fully supported by this study. The numbers of scored elements in these descriptive categories evidenced their importance in self-imagining; however, their proportionate representation in the imaginings was not significant. There may be other characteristics or mechanisms of self-reference that may mediate the advantage of self-imagining found in prior studies. Future studies may look into other aspects of
imaginings, such as references to personality traits, perspective of the participant (field or observer) in the imagining, and/or may test alternative types of stimuli to determine which are most effective in memory processing using self-referential elaboration. This study presented stimuli which were words which occur with high frequency and were judged to have "concreteness". Alternatively, targeting specific actions or specific locations for retrieval may be more salient in imaginings and may be recalled more effectively. For example, instructing the participant to imagine him/herself driving to their dentist’s office may advantage prospective memory for next week’s dentist appointment. Perhaps, also, the personality traits most consistently identified by persons who have sustained TBI as salient to their self schema should be the focus of the mnemonic task. These are areas which may be the foci of future investigation.

This study did not find a mnemonic advantage of self-imagining over other-person imagining; therefore, the second hypothesis was not supported by the data. In addition to the two elaboration conditions studied, the nature of the memory task may have contributed to the lack of significant mnemonic findings. A recognition test is generally an easier test of memory for participants than other types of memory tests, such as cued or free recall. Recognition tests may rely more on semantic knowledge while it has been suggested that recall tests tap into episodic memory. Because self-imagining elicits both self-referential information and visual imagery in an episodic-like manner (e.g., “I see myself playing with Fido, my dog, in my living room before dinner."), a recall test may be better for testing for the SIE. Future studies may investigate the effect of imagining content on immediate and delayed recall.

We studied two groups: healthy controls (n=16) and persons with neurological damage due to TBI who suffer memory impairment (n=4). The small sample size in persons with
memory impairments is likely to have impacted the findings. In several categories of imagined elements, the effect size of population, \( \eta^2 \), was large enough to suggest that a main effect of encoding condition might be demonstrated with increased statistical power. While it is relatively easy to increase the number of participants in the healthy control group, increasing the number of the memory-impaired participants is more difficult in that recruitment requires identification of persons with TBI in the general population. Therefore, access to support groups for persons with TBI and their caregivers is critical if future studies are going to sample a large enough population to provide sufficient statistical power.

In studies which compare the performance of healthy controls to the performance of persons with neurological damage and impaired memory function, it is necessary to vary the testing procedures. Clearly, cognitive functioning is impaired in the persons who have suffered a TBI. They often do not have the cognitive stamina of healthy participants, process information more slowly, and, generally, perform more poorly on memory tasks compared to healthy participants. Therefore, participants with neurological damage cannot be expected to perform at an equivalent level to healthy participants. In this study, we sought to recognize the differences which exist between healthy controls and persons who have suffered a TBI by inserting a 30 minute delay between the encoding task and test for persons who have suffered a TBI and a 24-hour delay for healthy controls. If encoding and delayed retrieval had been the same, the procedure would likely have resulted in “floor” effects in persons with memory impairment and “ceiling” effects in healthy controls. To the extent that the two groups performed equivalently, the study methodology applied to persons with memory impairment may have overcompensated for the anticipated differences in performance, suggesting longer delays and/or different type of memory testing would have been appropriate.
Word recognition performance was assessed using a 2x2 mixed ANOVA. Although study was designed primarily to investigate the content of the imaginings in order to verify that self-referential knowledge was, indeed, being accessed when the instruction was to “imagine yourself ...” and that self-referential knowledge was not being accessed when the instruction was to “…imagine the movie star…”, we did expect to find evidence supporting the SIE in both healthy controls and persons with memory impairment. However, this study did not include a baseline condition in that both the SRE and the SIE had been shown in previous studies (Grilli and Glisky, 2010, 2011, 2012), and, therefore, an advantage over semantic or structural elaboration could not be identified. A further potentially problematic area of this study is that the healthy controls were recruited from the population of young college students (mean age=21.6 years) while the participants with memory impairment were older (mean age = 46 years). Better matching of participant samples in age, education and socio-economic standing would represent an improved control condition. The difference in the age of the two populations tested is of concern given the generally acknowledged effect age has on memory function.

Importantly, confirmation of the advantage of self-imaginings to retrieval of information over longer periods of time will also be necessary before rehabilitation protocols can be designed and become effective.
References


Appendix 1: Coding Categories

Location: place, structure, geography

LP  Personal: My house, our car, in my room
LOS Other Specific: the UofA Mall, Park Place, Teton National Park, Dairy Queen
LG  Generic: a park, a mountain, a lake, the bathroom, his home

Agents: who is mentioned; subjects of the sentence

AP  Personal: I, me, we, our, my, myself, ourselves
AOS Other Specific: the movie star, Brad Pitt, my sister, his mother, the fireman, a teacher, he, she, they, him, her, them
AG  Generic: a woman, a man, some people, a dog

Event:

ES  Specific: Actions taking place like an episodic memory: subject of imagining is doing something actively at a specific date, time, and/or place
EG  General: Actions taking place but are not "episodic" in nature
EO  Event-Other: Description of object, general knowledge, no subject interacting or doing something with target word.

Perceptual Details/ Emotion:

PD  Number of sense related comments, e.g., I see, a loud bark, dark skies, tastes good, feels rough... time, sight (e.g. color, bright), smell, taste, hearing (e.g. loud, soft, shrill), touch, distance, weight
EM  An emotion or mood expressed and/or referred to, e.g., happy, scared, sad, tired, relieved, worried, anxious, nervous, excited