# Classification of general and personal semantic details in the Autobiographical Interview

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**Abstract**

The Autobiographical Interview (AI) separates internal (episodic) and external (non-episodic) details from transcribed protocols using an exhaustive and reliable scoring system. While the details comprising the internal composite are centered on elements of episodic memory, external details are more heterogeneous as they are meant to capture a variety of non-episodic utterances: general semantics, different types of personal semantics details, metacognitive statements, repetitions, and details about off topic events. Elevated external details are consistently observed in aging and in neurodegenerative diseases. In the present study, we augmented the AI scoring system to differentiate subtypes of external details to test whether the elevation of these details in aging and frontotemporal lobar degeneration (including mixed frontotemporal/semantic dementia [FTD/SD] and progressive non-fluent aphasia [PNFA]) would be specific to general and personal semantics or would concern all subtypes. Specifically, we separated general semantic details from personal semantic details (including autobiographical facts, self-knowledge, and repeated events). With aging, external detail elevation was observed for general and personal semantic details but not for other types of external details. In frontotemporal lobar degeneration, patients with FTD/SD (but not PNFA) generated an excess of personal semantic details but not general semantic details. The increase in personal but not general semantic details in FTD/SD is consistent with prevalent impairment of general semantic memory in SD, and with the personalization of concepts in this condition. Under standard AI instructions, external details were intended to capture off-topic utterances and were not intended as a direct measure of semantic abilities. Future investigations concerned with semantic processing in aging and in dementia could modify standard instructions of the AI to directly probe semantic content.

## 1. Introduction

In translating Tulving's (Tulving, 1972, 1983, 2001) episodic-semantic distinction from laboratory observation to real-life, a key challenge has been the measurement of these constructs in narrative recall of autobiographical events, where semantic information encompasses both publicly shared knowledge about the world as well as personal factual information about oneself. The episodic-semantic distinction is most transparently evident in neuropsychological cases of amnesia in which autobiographical episodic memory is grossly impaired while various elements of semantic memory are relatively spared (e.g., Kinsbourne, 1987; Levine, et al., 1998; Steinvorth, Levine, & Corkin, 2005; Tulving, 1985; Tulving, Schacter, McLachlan, & Moscovitch, 1988). On the other hand, this distinction is less conspicuous in the narratives of healthy adults or in other neuropsychological syndromes that contain a mixture of semantic and episodic elements, as it is normal to describe both temporally extended facts and temporally specific details when describing past events.

Inspired by Tulving, the Autobiographical Memory Interview (AMI; Kopelman, Wilson, & Baddeley, 1989), explicitly probes personal semantic knowledge and episodic autobiographical incidents (i.e., personal events specific in time and place, scored according to examiner ratings for specificity) in separate interviews, enabling documentation of dissociations across these mnemonic processes in various samples (e.g., Gilboa, et al., 2005; Jelovac, O'Connor, McCarron, & McLoughlin, 2016; Kopelman, 1994). However, these interviews are not matched in difficulty or psychometric characteristics that can affect patterns of responses outside of genuine differential impairment in mnemonic processes (Kapur, 1999; but see Rensen, et al., 2017). Additionally, the scoring system neither captures the incidental semantic information provided during description of autobiographical

incidents, nor the incidental episodic information generated while answering personal semantic questions.

In the Autobiographical Interview (AI; Levine, Svoboda, Hay, Winocur, & Moscovitch, 2002), participants are instructed to freely describe events specific in time and place according to cues (usually lifetime periods) in a manner broadly similar to those for autobiographical incidents in the AMI (i.e., that the events are specific in time and place). Rather than attempt to separate episodic and non-episodic at the level of examiner instructions, the AI does so at the time of scoring through the classification of details as internal (episodic) and external (non-episodic, including semantic but also other types of details as described below) from transcribed protocols using an exhaustive and reliable scoring system. The internal detail composite reflects components definitive of episodic memory as described by Tulving, considered to reflect the "what, where, and when" of episodic memory (Tulving, 1972) as well as the autonoetic component of re-experiencing (Tulving, 2002), including recovery of happenings, objects, perceptual, spatial, temporal, and emotional or cognitive events. The external composite is more heterogeneous, intended to capture a variety of non-episodic utterances, including metacognitive statements, repetitions, and details about off topic events, as well as the semantic details.

The original intent of the AI was to assess episodic autobiographical memory, exclusive of non-episodic content (with logic similar to that applied in other "exclusion" paradigms, such as the process dissociation procedure; Jacoby, 1991). The AI scoring method has proven fruitful in a variety of contexts, used in over 200 studies in various samples to date (see AutobiographicalInterview.com and Sheldon et al., 2018 for review). In particular, the distinction between internal and external details has been relevant in studies of aging (Levine,

Svoboda, Hay, Winocur, & Moscovitch, 2002; St Jacques & Levine, 2007), neurodegenerative diseases (Carmichael, Irish, Glikmann-Johnston, Singh, & Stout, 2019; Irish, et al., 2011; McKinnon, et al., 2008; Murphy, Troyer, Levine, & Moscovitch, 2008; Seixas Lima, et al., 2019), epilepsy (Addis, Moscovitch, & McAndrews, 2007; Milton, et al., 2010) and psychiatric conditions (McKinnon, et al., 2015; Soderlund, et al., 2014). Both patient (Addis, et al., 2007; Rosenbaum, et al., 2008; Steinvorth, et al., 2005), and neuroimaging studies (Hodgetts, et al., 2017; Memel, Wank, Ryan, & Grilli, 2020; T. D. Miller, et al., 2020; Palombo, et al., 2018) have demonstrated an association between internal details and the medial temporal lobes.

The external detail composite was originally intended to test the hypothesis that non-episodic processes (particularly semantic memory) were unaffected in aging and other conditions affecting episodic memory, and to assess overall verbosity as a potential confound in the interpretation of group differences in internal detail production. Surprisingly, external details were reliably elevated in aging, enhanced by cueing (initially intended to reduce age differences), and insensitive to lifetime period (Levine et al., 2002). This effect held under various replications and extensions (e.g., Addis, Wong, & Schacter, 2008; St Jacques & Levine, 2007). Moreover, the external detail enhancement is observed in neurodegenerative disease (e.g., Irish, Addis, Hodges, & Piguet, 2012; Irish, et al., 2011; McKinnon, et al., 2008; Seixas Lima, et al., 2019), traumatic brain injury (Esopenko & Levine, 2017), PTSD (McKinnon, et al., 2015), as well as other conditions (e.g., Mercuri, et al., 2015). In the 2002 study, we suggested that elevated external details in aging could be due to higher-level deficits in the control over retrieval of autobiographical episodes (for similar interpretation in other conditions, see Esopenko & Levine, 2017; Levine, 2004; McKinnon et al., 2015), a hypothesis supported by reduced network coupling in aging in association with external details (Spreng, et al., 2018; see also Hodgetts et al. 2017).

In general, the external composite is dominated by semantic details (Levine et al., 2002). In the AI scoring protocol, general semantics (e.g., “In 1989, Boris Becker had won Wimbledon 3 times”) and personal semantics details (e.g., “I was never good at tennis”) are not differentiated. While early descriptions assumed that personal semantics was part of semantic memory, there is evidence that personal semantics may be at least partially distinct from general semantic, as well as from episodic memory (Renoult, Davidson, Palombo, Moscovitch, & Levine, 2012), a conjecture supported by dissociations between personal semantics and (general) semantic memory (Grilli, Bercel, Wank, & Rapcsak, 2018; Grilli & Verfaellie, 2014, 2016; Marquine, et al., 2016; Renoult, et al., 2015; Renoult, et al., 2016; Tanguay, et al., 2018). Moreover, personal semantic details themselves may be fractionated into categories such as autobiographical facts, memory of repeated events and self-knowledge, which may have different behavioral and neural correlates (Renoult et al., 2012; 2016; Tanguay et al., 2018).

In the present study, we modified the AI scoring system to more carefully consider different categories of personal semantic details and their relation to aging and various neurological conditions. We and others have discussed these subtypes of personal semantics and how their neural bases may be at least partially distinct from general semantic memory. Some investigators have proposed that personal semantics may have a crucial role to retrieve episodic memories (Conway & Pleydell-Pearce, 2000; Barsalou, 1988). Yet, little is known about the spontaneous occurrence of subtypes of personal semantics and their relative importance in freely recalled narratives. Strikwerda-Brown et al. (2018) proposed a method to split external details from the AI into various types of semantic details and reported the results of this scheme in groups of patients with Alzheimer’s disease and with semantic dementia. The external details were classified as “specific episodes” (lasting less than 24

hours but separated from the main internal event (originally described by Levine et al., 2002 as external event details), “extended episodes” (either repeated or lasting more than 24 hours), personal semantics (corresponding to autobiographical facts and self-knowledge in the Renoult et al. 2012’s taxonomy), and general semantics. Strikwerda-Brown et al. (2018) did not differentiate autobiographical facts and self-knowledge in their taxonomy, even though these two types of personal semantics have been shown to have different neural correlates (e.g., Grilli et al., 2018; Klein & Lax, 2010; Renoult et al., 2016). Other types of non-semantic external details (e.g., repetitions and other unclassifiable utterances such as metacognitive statements) were not reported. As a young sample was not included, the effects of normal aging on categories of personal semantic detail production are unknown.

Here, we report a new taxonomy to separate external details in the AI, based on the Renoult et al. (2012) taxonomy, and report general semantic details and three types of personal semantic details (autobiographical facts, self-knowledge and repeated events), along with other non-semantic types of external details. As an initial application of this taxonomy, we re-analyzed previously published data from neurodegenerative disease and aging samples. As noted above, we previously reported reduced internal and elevated external details in aging (Levine et al., 2002; St Jacques & Levine, 2007) and frontotemporal lobar degeneration (FTLD), an early onset progressive neurodegenerative condition affecting the frontal and temporal lobes encompassing frontotemporal dementia (FTD), semantic dementia (SD), and primary progressive nonfluent aphasia (PNFA; McKinnon, Black, Miller, Moscovitch, & Levine, 2006; McKinnon, et al., 2008). In FTLD, this effect was confined to the FTD and SD patients in association with volume reductions in the medial temporal lobes bilaterally, as well as left-lateralized posterior (parietal and occipital) volume reductions; PNFA patients were not affected, presumably due to sparing in the critical regions affected in

FTD and SD. We also found that the pattern of reduced internal and increased external details was enhanced with disease progression upon serial testing after one year.

In the present report we reanalyzed the external details of these participants, according to our personal semantic detail classification scheme. In particular, we were interested to test whether the elevation of external details in aging and in dementia would be specific to general and personal semantics or would concern all types of external details. Given effects on inferolateral temporal lobe structures mediating semantic knowledge, we predicted that production of general semantics would be reduced in association with damage to these regions (Lambon Ralph, Jefferies, Patterson, & Rogers, 2017; Renoult, Irish, Moscovitch, & Rugg, 2019) as assessed by high resolution structural MRI. In the case of personal semantics, few studies have compared subtypes of personal semantics to both general semantic and to episodic memory, and no study to our knowledge has compared autobiographical facts, repeated events, and self-knowledge. In the case of autobiographical facts, this subtype of personal semantics has been shown to rely on lateral temporal lobe regions (Gilboa, et al., 2005; Hodges, Patterson, Oxbury, & Funnell, 1992; Renoult, et al., 2012), but also on restrosplenial and medial prefrontal cortex (Maguire & Frith, 2003; Maguire & Mummery, 1999). For self-knowledge, medial prefrontal cortical regions have been the most consistently associated brain regions (Marquine, et al., 2016; Martinelli, Sperduti, & Piolino, 2013). Finally, memories for repeated events have sometimes been associated with similar activation of the hippocampus and other medial temporal lobe regions as memories of unique events (Addis, McIntosh, Moscovitch, Crawley, & McAndrews, 2004; Addis, Moscovitch, Crawley, & McAndrews, 2004; Levine, et al., 2004), but also with distinct activations, such as greater lateral parietal cortex activity than unique events (Holland, Addis, & Kensinger, 2011; Levine, et al., 2004).

Decomposing these external details into different subcategories, Strikwerda-Brown et al. (2018) reported that, in their group of dementia patients (SD and Alzheimer's), general semantic details were elevated and, in the case of SD patients, there was no difference in personal semantic details with control participants, an unexpected finding considering the prevalent impairment of semantic memory in SD (Lambon Ralph, Jefferies, Patterson, & Rogers, 2017). Similarly, one might expect personal semantics details to be elevated in SD, given the personalization of concepts in this condition (Snowden, Griffiths, & Neary, 1994; Snowden, Griffiths, & Neary, 1995, 1996; Snowden & Neary, 2002; Westmacott, Leach, Freedman, & Moscovitch, 2001). That is, at least some aspects of autobiographical facts (e.g., Snowden et al., 1994; Snowden et al., 1996) and self-knowledge (Duval, et al., 2012; B. L. Miller, et al., 2001; see also Klein & Lax, 2010) are sometimes better preserved than general semantics in SD. For instance, SD patients have been reported to have better recognition of personally-known individuals, places, and objects than similar non-personally relevant exemplars of these categories, a pattern not seen in amnesic Alzheimer's patients (Snowden, et al., 1994; see also Snowden, et al., 1995; Snowden, et al., 1996).

We hypothesized that SD and mixed FTD/SD patients would show a greater increase in external details for personal semantics (at least autobiographical facts and self-knowledge), as compared to general semantics. We are not aware of any studies that have specifically investigated memories of repeated events in FTLD patients, but the relative preservation of event memory and the strong preference for routine that sometimes develop in SD patients (Strikwerda-Brown, Grilli, Andrews-Hanna, & Irish, 2019) suggests that memories of repeated events could also be increased in this sample. The PNFA patients provide a closely matched neurodegenerative comparison group with damage sparing the key mnemonic regions

affected in FTD and SD, and are therefore expected to show a normal profile of external details (McKinnon et al., 2008).

Little is known about personal semantics and its subtypes in aging, and in particular which types of semantics would be elevated in this population. This information is necessary to contextualize results from neurodegenerative samples, where aging and neuropathological effects are co-existent. Recent data from Acevedo-Molina and colleagues (Acevedo-Molina, Matijevic, & Grilli, 2020) suggest that both personal and general semantics would be elevated in the context of normal cognitive aging. We thus reanalyzed the external details of groups of young and older adults (Levine et al., 2002; St Jacques et al., 2007) to identify whether the elevation of external details in aging would be specific to general and personal semantics (and any particular subtypes) or would concern all types of external details and thus rather reflect a more general deficit in executive control over memory (Levine et al., 2002; McKinnon et al., 2015; Spreng et al., 2018).

## 2. Methods

### 2.1. Participants

The younger and older adults (*N* = 30 per group) were drawn from previously published samples from studies of aging, as well as comparison participants used for other studies of clinical groups (Davidson, et al., 2008; Esopenko & Levine, 2017; Levine, et al., 2002; Rosenbaum, et al., 2008; St Jacques & Levine, 2007). All participants were screened for history of significant psychiatric or neurological disorders that could affect performance. Older adults were screened for dementia. The FTLD sample and matched control participants were drawn

from a previous published study (McKinnon et al., 2008), as well as two SD patients from (McKinnon et al., 2006). These patients were recruited from academic clinics where they were diagnosed according to standard consensus criteria for FTD, SD, and PNFA at the time of assessment (Neary, et al., 1998). As many of the SD patients also met criteria for FTD, we created a combined FTD/SD group (including the two "pure" SD patients from McKinnon et al., 2006). The groups consisted of eight FTD patients; five PNFA patients, and 11 mixed FTD/SD. There were no significant differences across groups for age, education, duration of illness or MMSE (see Table 1). An age- and education-matched group of participants were used for the purposes of comparison to the FTLD participants.

| | **Age** | **Education** |
|---|---|---|
| **Old** | 76 (6.33) | 14 (2.68) |
| **Young** | 25.03 (4.38) | 15.21 (1.95) |

| | **Age** | **Education** | **Onset (yrs)** | **MMSE** |
|---|---|---|---|---|
| **FTD** | 59.38 (6.00) | 15.5 (3.96) | 3.75 (2.61) | 25.88 (3.31) |
| **FTD/SD** | 58.09 (7.34) | 15.46 (2.98) | 4 (1.18) | 26.82 (3.49) |
| **PNFA** | 65.6 (10.41) | 17.25 (2.99) | 2.75 (1.71) | 27.8 (1.48) |
| **Control** | 57.12 (9.11) | 16.47 (2.96) | | |

**Table 1.** Demographic and clinical characteristics of participants.

### 2.2. AI Administration

The administration procedure followed the method described in Levine et al. (2002), where participants select personally experienced events that occurred at a specific time and place

from each of five life periods. However, for the sample of young and older adults of St Jacques & Levine (2007), participants selected six specific events (two negative, two positive, and two neutral) that had occurred in the past five years, excluding the past six months. Because of the methodological differences across these two studies, we included Study as a factor in our analysis. As there were no significant main effects or interactions involving this factor, we report the data for the data combined across the two studies. The AI administration entails three probing levels: Free Recall (extemporaneous recall following the cue), General Probe (clarification of instructions (i.e., such as when the participant provides a non-specific event) or encouragement to elaborate if the response is impoverished (i.e., "Can you tell me more?"), and Specific Probe, which includes probing for internal details and ratings. To avoid contamination of earlier probe levels, the Specific Probe condition is administered after free recall and general probe has been completed for all events. The St.-Jacques and Levine (2007) study did not include Specific Probe. As noted below, the present analysis is restricted to the responses at Free Recall and General Probe.

### 2.3. AI Scoring

All data had been previously scored according to the standard AI criteria (Levine et al., 2002). The present report concerns external details, which in the original scoring method include semantic, external event, repetitions, and other details. To derive the new semantic detail categories (see below), semantic details were reclassified as autobiographical facts, self-knowledge, repeated events, or general semantics (see below). For the remaining external detail categories, the original scored classification was carried over. We focused on Free Recall and General Probe protocols as these were available for all participants. Furthermore,

responses to Specific Probe could be contaminated by examiner queries that are designed to elicit internal details and are dependent on the information provided at prior probing levels (e.g., if full location details were already provided, these are not sought at Specific Probe).

There were 644 individual memories scored for this report. These were assigned to seven scorers who had been previously trained by B. Levine (the main developer of the AI) and who had already attained reliability coefficients of .90 or higher for internal and external detail classification on a separate set of practice memories. Assignment was pseudorandom such that participants' individual memories and group was equally represented across scorers. Memories were scored from a general pool containing participants for multiple studies; scorers were blind to group.

Scorers were trained on the distinctions across semantic categories by L. Renoult and B. Levine. They were provided with a scoring manual that included definitions of each category and scoring examples (see appendix). The scoring team discussed the scoring criteria as applied to sample memories, which resulted in modifications to the manual to increase clarity. To assess reliability, 10 memories (from younger and older participants and dementia patients) were randomly selected (again with the constraint that younger, older, and FTLD patients were represented) and scored by all seven scorers, again blinded as to which memories were being included in the reliability study. Inter-rater reliability was assessed with the Intraclass correlation coefficient (ICC; two-way, random effects model). Scorers were blind to which memories were evaluated for reliability. Single measures ICCs were: .94 overall, with .84 for general semantics and .95 for personal semantics (.96 for autobiographical facts, .92 for self-knowledge, .65 for repeated events).

To address significant positive skewness that is typical of AI data, we applied a Winsorization procedure to the data by which detail counts exceeding ±2.5 SD from the mean were rescaled to be 2.5 SD from the mean (McKinnon et al., 2008; McKinnon et al., 2015). Finally, participants' details were averaged across memories so that scores could be compared across participants with different numbers of memories.

### 2.4. Separating personal from general semantics

In the present report, we include instructions on how to separate external details into general and personal semantics, but also give indications on how to discriminate between three different subtypes of personal semantics that we have described in our taxonomy: autobiographical facts, memory of repeated events, and self-knowledge (Renoult et al., 2012; see also appendix). We did not consider the category of autobiographically significant events in the present report (Renoult et al., 2012; Renoult et al., 2015; Westmacott & Moscovitch, 2003), as autobiographical significance would have to be queried in individual participants for each relevant concept.

*Categories of external details: Separating personal from general semantic details*

Semantic memory is most often defined as general, culturally shared knowledge, such as knowledge of facts, public events, concepts and people (Binder & Desai, 2011; Hart, et al., 2007; Martin, 2001; Renoult, 2016; Renoult, et al., 2019). It refers to public, accessible information with enough general awareness that it can be shared by members of a culture. In contrast, personal semantics refers to knowledge of one's past and is thus idiosyncratically

personal. To classify external details as general or personal semantics, scorers considered whether a knowledge item was presumably culturally shared or not. For example, for knowledge about people, the sentence clause *"Justin Trudeau has a brother named Michel"* would be scored as general semantics, whereas "*I have one brother; his name is Michel*" would be scored as personal semantics. As a heuristic, as long as one considers that members of the culture or of a relevant social group (e.g., same country, city, depending on what is relevant in the context) would not necessarily share that knowledge, then it would be scored as personal semantics.

The distinction between general and personal semantics can depend on the context, such as the visual perspective that is apparent in the narrative. Whereas general semantics is thought to always involve a 3rd person perspective, personal semantics can sometimes involve a 1st person perspective like episodic memory (Tulving, 1989), which is often the case for memories of repeated events (e.g., *"I used to come here with Michel during college"*). If there was doubt between general and personal semantics, the assumption of a 1st person perspective in a specific narrative was used to classify an external detail as personal semantics.

*Three types of personal semantics*

Autobiographical facts concern knowledge of basic but objective elements of our past, resembling a skeletal autobiography (Warrington & McCarthy, 1988), e.g., *"I lived on Broke street", "I have 2 children*". Autobiographical facts also include knowledge about personal acquaintances and close-others, e.g., *"My brother's name is Michel", "My sister is quiet"* (Grilli & Verfaellie, 2014; Renoult, et al., 2012). These facts are personal, as they are specific to an

individual, but do not necessarily concern the self, as illustrated in the examples above. As noted by Grilli and Verfaellie (2016), some of these autobiographical facts are experience-near and include some spatio-temporal contextual information *("It was the first time that I had gone to Paris*"), while others are experience-far and more abstract (e.g., *"I was born in Paris"*).

Self-knowledge is typically operationalized as knowledge of our personality traits and attributes, has a clear subjective aspect, and focus on the self and internal states: *"I am persistent", "I am scared of airplanes"*. Self-knowledge also includes personal beliefs, opinions and knowledge about personal preferences for self *("I love custard tarts"; "I like gardening"*), as well as more emotional aspects of personal knowledge (e.g., *"I feel badly when I have to complain to someone*"). Self-knowledge can thus be differentiated from autobiographical facts as referring to subjective knowledge and self-image, as compared to the more objective aspect (skeletal CV) of autobiographical facts.

Memories of repeated events involve recalling common elements of multiple episodes of our personal past, e.g., "*I used to feed her"*, and can include temporal *("We had Christmas at Grandpa's every year"*) or spatial *("I used to walk Rex in that park"*) information. Memories of repeated events can be differentiated from experience-near autobiographical facts (see above) that refer to a unique instance (e.g., *"We had Christmas in Florida that year"*). Moreover, whereas memories of repeated events are personal in content ("*e.g., "I was going to the grocery store every week while I lived in Europe"),* as mentioned above autobiographical facts do not necessarily concern the self and include knowledge about personal acquaintances and close-others *(e.g., "My friend Bob goes to the grocery store every week";* see Table 2).

| Type of detail | Classification |
|---|---|
| Culturally-shared knowledge (e.g., same country, city or neighborhood, depending on what is relevant in the context) | General Semantics |
| Personal opinions | Self-Knowledge |
| Knowledge of people<br>- Famous people<br>- Personal acquaintances<br>- Self | <br>General Semantics<br>Autobiographical Facts<br>Self-Knowledge |
| Basic (objective) information about personal life circumstances | Autobiographical Facts |
| Self-reflective (subjective) information about traits and personality | Self-Knowledge |
| Recall of common elements of repeated episodes | Repeated Events |
| Recall of factual elements from unique episodes | Autobiographical Facts |

**Table 2:** Summary of scoring rules (see appendix for additional details)

### 2.5. Statistical analyses

For each participant, detail categories were computed as averages across all memories probed (i.e., 5 lifetime periods or 6 events as in St.-Jacques & Levine, 2007; analysis by time period did not add additional information to the findings reported here). Detail type was analyzed as a within-subject factor using repeated-measures ANOVAs, with seven levels (general semantics, autobiographical facts, self-knowledge, repeated events, details about external events, Repetitions, and "Other" details), and participant group as a between subject factor (young versus older adults; control versus dementia patients (FTD patients; mixed SD/FTD; PNFA patients). The external event category reflected the sum of external Event, Place, Time, Perceptual, Emotion/Thought details (i.e., all details concerning specific episodes other than the identified "main event" in the protocol). The "Other" details category includes metacognitive statements, editorializing, inferences, or other statements that convey

verbosity but are not related to the main event (see Levine et al., 2002). Post-hoc comparisons between memory types were run with paired-samples t-test, with a $p<.01$ threshold to correct for family-wise error rate.

**2.6. Imaging**

FTLD participants also received a high-resolution 1.5 T structural MRI scan that was quantitatively analyzed for volume changes in over 36 semi-automatically defined brain regions (per hemisphere: 6 frontal, 4 cingulate, 3 temporal, 2 parietal, 1 occipital, 2 subcortical grey matter [basal ganglia/thalamus]; Dade et al., 2004; one small region, the internal capsule/corona radiata was excluded from this analysis as it was unreliable). Regional CSF volumes were analyzed, treated as the inverse of total parenchyma (grey + white matter). These were adjusted for total intracranial capacity using a regression-based method (Arndt, Cohen, Alliger, Swayze, & Andreasen, 1991). As reported previously in this same FTLD sample, this protocol was sensitive to both specific regional effects according to FTLD diagnosis (e.g., FTD vs. SD vs. PNFA), to interval change upon rescanning after one year (see McKinnon et al., 2006; 2008), and to the overall pattern of reduced internal and increased external details on the AI.

Behavioral partial least squares analysis (behavioral PLS; Krishnan, Williams, McIntosh, & Abdi, 2011; McIntosh & Lobaugh, 2004), a data-driven multivariate technique, similar to principal components analysis, was used to identify potential relationships between memory characteristics and neuroanatomical variations. In PLS, data decomposition is performed in one step, hence eliminating the need for multiple comparison correction. Behavioral PLS was implemented using a series of Matlab scripts, which are available for download at

https://www.rotman-baycrest.on.ca/index.php?section=345. The brain matrix contained the volumes of all 36 ROIs, concatenated across all patients, whereas the behavioral matrix comprised the number of details, generated by each patient within each category. Based on these matrices, PLS extracted pairs of latent variables (LVs), specifically, one LV based on the brain matrix and one LV based on the behavioral matrix, with the constraint that each pair of LVs shared the maximum amount of covariance possible. The significance of each LV pair was determined using a permutation test with 5000 permutations (in the permutation test, the rows of the brain data are randomly reordered, Krishnan et al., 2011). The reliability of each brain or behavioural variable's contribution to its corresponding LVs was tested by submitting all weights to a bootstrap estimation (1000 bootstraps) of the standard errors; the bootstrap samples were obtained by sampling with replacement from the participants (Krishnan et al. 2011). These parameters (i.e., 5000 permutations/1000 bootstrap samples) were selected in order to increase the stability of the reported results, since they are ten times greater than the standard ones, recommended by McIntosh and Lobaugh (2004) for use in PLS analyses of neuroimaging data.

## 3. Results

### 3.1. AI Ratings

#### 3.1.1. Young and Older adults

Analyses in the young and older adults (N=30 in each group) revealed a main effect of external detail type, $F_{6,348} = 88.89$, $p < .001$, $\eta^2 = .61$, and an interaction between detail type and group ($F_{6,348} = 11.69$, $p < .001$, $\eta^2 = .17$; see Table 3 and Figure 1). Across groups, the profile was

dominated by autobiographical facts, with general semantics and repeated events the least common category and self-knowledge falling between the two. Following-up on the interaction between detail type and group, we found that older adults produced more semantic details than younger adults across all the defined categories (all *ps* < .001, except p=.003 for repeated events; see Figure 1). There was a smaller increase in external event details (p=0.042) that did not cross our adjusted significance threshold. The number of repetitions and "other" external details were similar between age-groups.

*External details in young and old adults*

| | Young | Old |
|---|---|---|
| *Semantic* | | |
| GS | .32 (.47) | 1.09 (.99) |
| AF | 5.27 (4.09) | 10.22 (4.68) |
| SK | 1.30 (1.09) | 3.04 (2.00) |
| RE | .45 (.49) | 1.06 (.95) |
| *Other external* | | |
| AllExt-Event | 2.13 (2.28) | 3.41 (2.49) |
| Rep | 2.57 (1.81) | 2.27 (1.13) |
| Other | 2.35 (1.97) | 2.74 (1.75) |

**Table 3.** Mean number of details of each category for the young and the older adults (N=30 in each group). GS: General Semantics. AF: Autobiographical Facts. SK: Self-Knowledge. RE: Repeated Events. Ext-Event: other external events (sum of Event, Place, Time, Perceptual, Emotion/Thought details for events other than the defined "main" event). Rep: Repetition. Other: Other details.

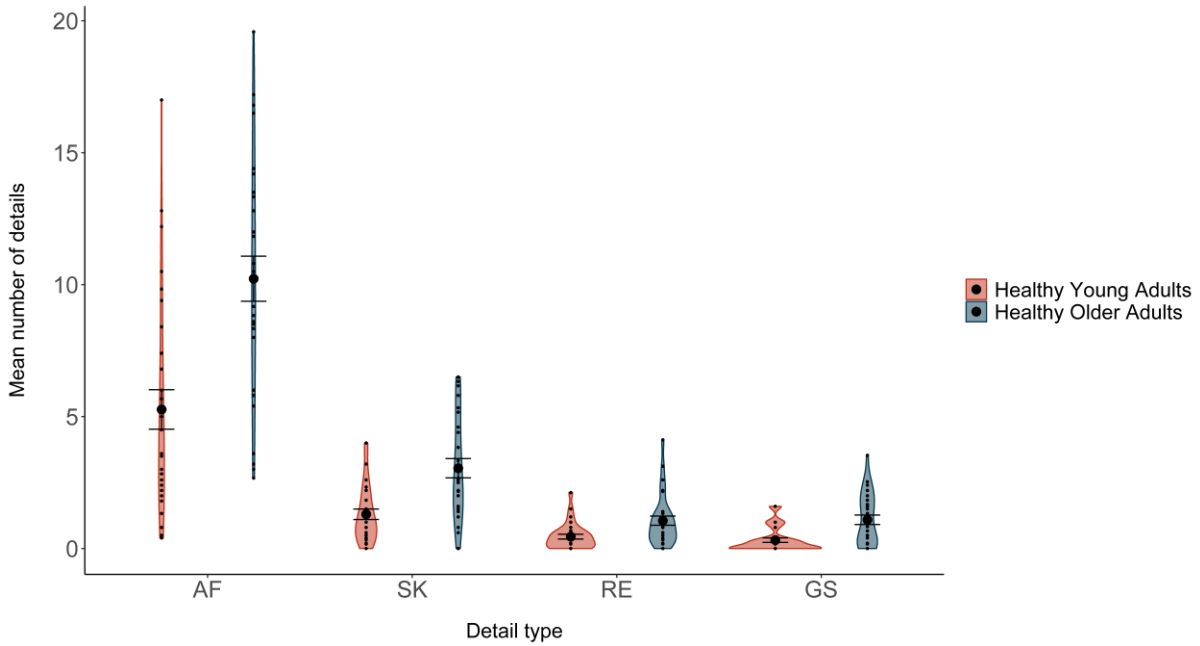


**Figure 1.** Violin plots for each category of semantic details in the young and the older adults (N=30 in each group). AF: Autobiographical Facts. SK: Self-Knowledge. RE: Repeated Events. GS: General Semantics.

### 3.1.2. Dementia patients versus Controls

Analyses in the dementia patients (N=24) and controls (N=16) revealed a main effect of external detail type $F_{6,228} = 30.22$, $p < .001$, $\eta^2 = .44$, and an interaction between detail type and group, $F_{6,228} = 5.71$, $p = .001$, $\eta^2 = .13$. As was the case in aging, the profile of semantic detail types across patients and controls was dominated by autobiographical facts (see Table 4 and Figure 2).

| | Controls | FTD | FTD/SD | PNFA |
|---|---|---|---|---|
| *Semantic* | | | | |
| GS | .46 (.49) | .94 (1.00) | .56 (.76) | .36 (.36) |
| AF | 3.75 (2.91) | 7.35 (5.12) | 11.40 (6.20) | 5.64 (3.67) |
| SK | .78 (.62) | .50 (.69) | 2.05 (1.57) | 1.08 (.92) |
| RE | .78 (1.23) | .38 (.38) | 2.51 (1.82) | 1.00 (.72) |
| *Other external* | | | | |
| AllExt-Event | 3.00 (3.12) | 4.35 (5.11) | 5.94 (5.74) | 2.92 (.92) |
| Rep | 1.98 (1.67) | 2.77 (2.48) | 2.20 (1.57) | 1.08 (1.36) |
| Other | 5.43 (3.34) | 4.45 (3.18) | 5.17 (4.47) | 3.44 (3.85) |

**Table 4.** Mean number of details of each category in the dementia patients (N=24) and the controls (N=16). FTD: frontotemporal dementia (N=8); PPA: primary progressive nonfluent aphasia (N=5), FTD/SD (N=11), mixed frontotemporal dementia and semantic dementia (SD) group. GS: General Semantics. AF: Autobiographical Facts. SK: Self-Knowledge. RE: Repeated Events. Ext-Event: other external events (sum of Event, Place, Time, Perceptual, Emotion/Thought details for events other than the defined "main" event). Rep: Repetition. Other: Other details.

In general, the amount of general semantic details produced by dementia patients did not significantly differ from controls ($p$=.41). However, there were many more autobiographical fact details in patients than in controls ($p$=.002). The other types of semantic details did not differ between these samples, nor did external details.

Following-up on the interaction between detail type and group ($F_{6,228}$ = 5.71, $p$ = .001, $\eta^2$ = .13), we considered the effect of detail types in each subgroup of dementia patients as compared to controls. FTD patients did not differ from controls for any detail type (though there was a trend for patients to generate more autobiographical facts details than controls, p = .038 that did not survive correction for multiple comparisons). FTD/SD patients did not differ from controls in their production of general semantic details but generated more of each type of personal semantics (p<.001 for autobiographical facts details, p=.007 for self-knowledge and p=.008 for repeated events), with the two "pure" SD patients showing a similar pattern to the mixed FTD/SD patients. PNFA patients did not differ from controls for any detail types.

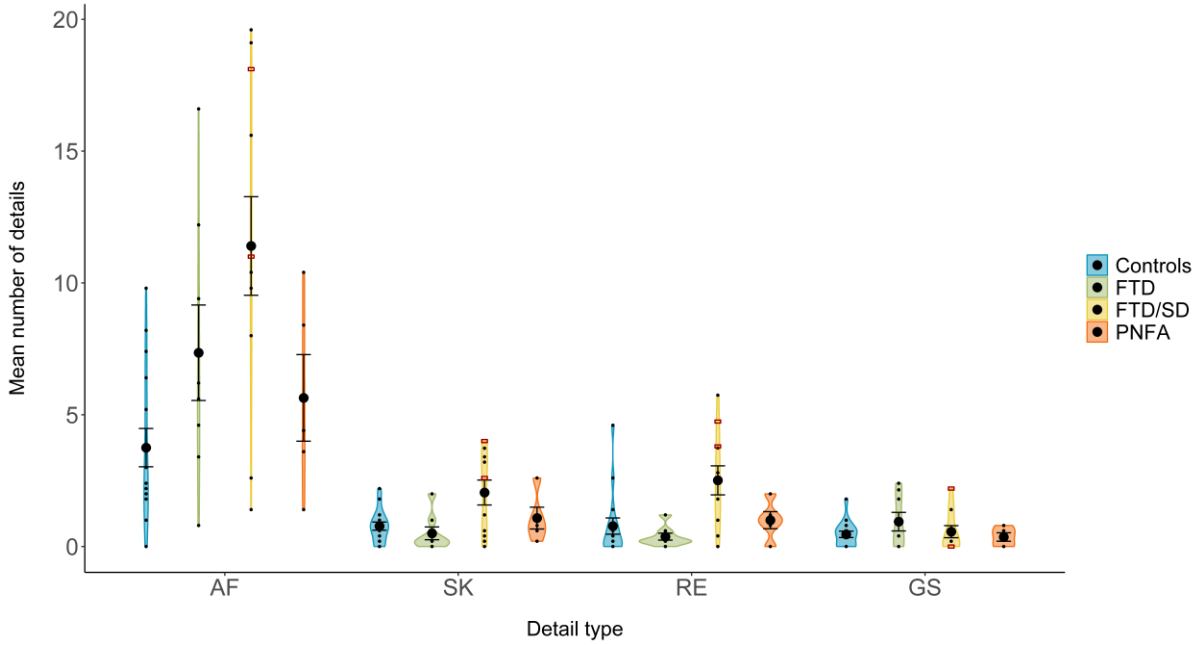


**Figure 2.** Violin plots for each category of semantic details in the dementia patients (N=24) and the controls (N=16). FTD: frontotemporal dementia (N=8); PNFA= Progressive non-fluent aphasia (N=5), FTD/SD (N=11), mixed frontotemporal dementia and semantic dementia (SD) group. The two "pure" SD patients are indicated with black squares. AF: Autobiographical Facts. SK: Self-Knowledge. RE: Repeated Events. GS: General Semantics.

### 3.2. Imaging results

The behavioral PLS analysis revealed no reliable associations between external detail types and volumetric variations in the selected ROIs (ps for all brain-behavior LV pairs > .12).

## 4. Discussion

Endel Tulving considered episodic autobiographical memory to be embedded in a semantic context (Tulving, 1985, 1995, 2001), a concept that was echoed in subsequent models of autobiographical memory (e.g., Barsalou, 1988; Conway, 2009; Conway & Pleydell-Pearce, 2000; Renoult, et al., 2012). He conceived episodic free recall as a dynamic process subject to organizational constraints (e.g., Sternberg & Tulving, 1977; Tulving, 1962). The narrative construction of spatiotemporally specific personal past episodes arises from integration

across multiple interactive brain systems centered upon the production of details that give rise to the subjective experience of mental time travel to the past (Tulving, 2002).

The Autobiographical Interview was inspired by these notions, with internal details considered to reflect episodic re-experiencing embedded in a semantic framework. In its original construction, the AI lacked elaboration and distinctions across the various elements of conceptual processes comprising semantic knowledge. The taxonomy of semantic memory, particularly, personal semantic memory, has since been refined (e.g., Renoult et al., 2012). The goal of the present paper was to develop and apply a new scoring scheme to the previously collected AI data to separate personal semantics and semantic memories into two distinct types of external details, as well as to identify subtypes of personal semantics, based on Renoult et al. (2012)'s taxonomy. We also sought to test whether the elevation of external details in aging and in dementia would be specific to general and personal semantics or would concern all types of external details.

While a number of studies have now described how different types of personal semantic memory are at least partially distinct from general semantic memory (Grilli et al., 2018; Grilli & Verfaellie, 2014; 2016; Marquine et al., 2016; Renoult et al., 2015; 2016; Tanguay et al., 2018), we know little about their spontaneous occurrence in free recall. We found that autobiographical facts dominated free recall across all samples, followed by self-knowledge. In accord with the AI instructions to report personal information, general semantics and memories of repeated events details were less frequent in the transcripts.

Overall, our findings complement previous investigations using the AI, which report increases in external details in aging and neurodegenerative disease (for review, see Sheldon et al., 2018). Here we show that, in aging and in FTD/SD patients, this increase is specific to

semantic details, as initially envisaged by Levine et al. (2002) using the original AI scoring scheme. Older adults showed elevated general and personal semantics of all subtypes (autobiographical facts, self-knowledge and repeated events), while FTD/SD patients show a selective increase in personal semantics.

Reanalyzing the external details of samples of young and older adults (Levine et al., 2002; St.-Jacques et al., 2007), we showed that elevation of external details in aging was reliable for semantic details but not for other external detail categories. This effect held across general and personal semantics subcategories. These results suggest that older adults' elevated production of external details is confined to semantic details, yet within this category the effect is non-specific. Elevation of non-semantic external details is thus not part of the normal aging profile under the standard AI instructions.

Consistent with McKinnon et al. (2008), we found that elevation of external details in frontotemporal lobar degeneration (FTLD) occurred mainly in FTD/SD patients. In contrast to the profile seen in normal aging, these patients generated an excess of personal semantic details – including autobiographical facts, self-knowledge and repeated events – but not general semantic details. A similar profile of semantic details was observed when we considered the "pure" SD patients separately (see Figure 2). The increase in personal but not general semantic details in FTD/SD is consistent with prevalent impairment of general semantic memory in SD (Lambon Ralph et al., 2017), and with the personalization of concepts in this population (Snowden et al., 1994; Snowden et al., 1995, 1996; Snowden & Neary, 2002; Westmacott et al., 2001). Indeed, SD patients have been reported to have better recognition of personally-known individuals, places, and objects than similar non-personally relevant exemplars of these categories (Snowden, et al., 1994; see also Snowden, et al., 1995;

Snowden, et al., 1996), but also better preservation of self-knowledge as compared to general semantic knowledge (Duval, et al., 2012; see also B. L. Miller, et al., 2001).The fact that personal semantic details (i.e., knowledge of autobiographical facts, repeated events and self-knowledge) were increased in the present study in these patients is thus consistent with these previous observations. The mechanisms behind this personalization of semantic knowledge in SD, however, is not perfectly clear. In the case of self-knowledge, some have proposed that it had a specific resilience and thus could be selectively preserved (Klein & Lax, 2010). Others have proposed that personalization of semantic knowledge in SD could be related to compensation mechanisms, with a greater reliance on episodic memory (Graham, Ralph, & Hodges, 1999; Westmacott, Black, Freedman, & Moscovitch, 2004; Westmacott, et al., 2001). In a study assessing the quality of SD patients' episodic and semantic autobiographical details using the AI, semantic details were rated as less coherent than episodic details, despite the fact that semantic details were greater in number (Seixas Lima, et al., 2019). That is, episodic details in SD were low in quantity but high in quality (i.e., coherence with the topic of discourse), whereas the opposite was true for semantic details, possibly due to a compromised capacity to select focused and relevant semantic information during retrieval (Seixas Lima, et al., 2019), a hypothesis that simultaneously accounts for the high quantity but low quality of semantic details in SD. These findings contrast with those of Strikwerda-Brown et al. (2018) who found elevated external event and general semantic details (recent periods only) in SD – but not personal semantic details – relative to controls, possibly due to differences in test administration (see below) or patient characteristics. In the FTD group, autobiographical facts were elevated relative to controls, but this was not statistically significant. The PNFA patients, with relative preservation of critical frontal and temporal

structures, were undifferentiated from controls in spite of their expressive language deficits (see also McKinnon et al., 2008).

It is acknowledged that the semantic subtypes described here are retrofitted upon a measure that was designed to assess episodic autobiographical memory. As the semantic detail subtypes are incidental and not prompted in the standard AI instructions, they cannot be taken to directly assess semantic processing capacity, as illustrated by the fact that they are lowest in healthy younger participants who presumably have no semantic processing impairment. Nonetheless, our findings support the distinction between different types of semantic content (Grilli, Bercel, Wank, & Rapcsak, 2018; Grilli & Verfaellie, 2014, 2016; Marquine et al., 2016; Renoult et al., 2012; 2015; 2016; Tanguay et al., 2018; Klein & Lax, 2010), particularly autobiographical facts ("I lived on Broke street", "I have 2 children"). The dominance of autobiographical facts in our participants' transcripts suggests that these basic but objective knowledge elements are essential aspects of our personal memories (Conway, 2005), resembling a skeletal autobiography (Warrington & McCarthy, 1988). As noted by Grilli and Verfaellie (2016), autobiographical facts are a relatively heterogeneous category, with some experience-near knowledge including spatio-temporal contextual information ("It was the first time that I had gone to Paris"), but also experience-far and more abstract knowledge (e.g., "I was born in Paris"). While we did not separate experience-near and experience-far autobiographical facts in the present report, it is a distinction that could be applied in future studies and that may help to further untangle the heterogeneity of autobiographical knowledge and related impairments in patient samples (Grilli & Verfaellie, 2014). Of note, Acevedo-Molina and colleagues (Acevedo-Molina, et al., 2020) recently examined this distinction in young and cognitively normal older adults. They found that the proportion of experience-near to experience-far personal semantics did not differ by age (aligning with the

non-specific personal semantic findings reported here). Also, Acevedo-Molina and colleagues (Acevedo-Molina, et al., 2020) separated external details for autobiographical episodic memories into personal semantics, general semantics, and "other" external details, and like in the present report, found that only semantics (both personal and general) were elevated in the context of normal cognitive aging.

The second most common category was self-knowledge, encompassing the more subjective aspects of personal semantics (knowledge of one's own traits, personal beliefs, opinions), perhaps illustrating a natural tendency to reflect on how episodes exemplify our personal identity (Conway, 2005). The frequency of these more subjective aspects of autobiographical narratives was also increased in ageing and in FTD/SD patients. Details concerning general semantics and thus public (objective) factual knowledge were generally infrequent, likely owing to the instructions to focus on specific personal episodes, although this category of details was elevated in older compared to younger adults. Providing such contextual details about public events taking place at the same time as the main event could serve to embellish the narratives, especially in older adults that have been shown to provide more "story asides" (Bluck, Alea, Baron-Lee, & Davis, 2016; see also Devitt, Addis, & Schacter, 2017). We note, however, that even though the present findings are informative about the spontaneous occurrence of specific types of personal and general semantics in narrative recall of autobiographical events, the relative ratios of details could be influenced by the use of standard AI instructions to provide details about unique episodes (see further discussion of this point below).

Contrary to our prediction, the finer grained semantic categories were not sensitive to patterns of localized neurodegeneration. This null finding could relate to reduced statistical

power given the measurement error inherent to the extraction of these categories from autobiographical narratives. The finding is not likely attributable to the insensitivity of our neuroimaging protocol, previously demonstrated as sensitive to diagnosis and disease progression in this same FTLD sample (McKinnon et al., 2006; 2008) as well as other samples (Esopekno & Levine, 2017; Rosenbaum et al., 2008). Moreover, these studies have consistently revealed localized patterns of volume loss in a variety of samples related to the internal/external distinction, with reduced internal details and increased external details associated with temporoparietal volume reductions, particularly in the medial temporal lobes.

The standard AI instructions require participants to retrieve unique episodes. By definition, the external detail composite reflects off-task mental activity (as defined by the instruction to describe a specific episode); it is this feature that unites the external detail categories such that their production reflects deficits in executive control over memory (Levine et al., 2002; McKinnon et al., 2015; Spreng et al., 2018), even though some semantic details are necessary to construct a narrative. As off-task behavior, external details show greater variability both within and across studies depending on test administration effects and participants' interpretations of instructions. For instance, the general semantic counts reported by Strikwerda-Brown et al (2018) for their neurodegeneration samples exceeded ours by approximately one order of magnitude. The weaker behavioural and brain effects associated with the finer-grained categories compared to the previously reported internal/external distinction underscores the usefulness of the composite external detail category as defined in the original AI criteria (Levine et al., 2002). By definition, a composite measure is more psychometrically robust than its individual components. Although our findings were broadly consistent with predictions, we note that for some categories (general

semantics, repeated events) detail counts were low. In spite of significant efforts to ensure consistency across scorers, these categories had corresponding lower interrater reliability as compared to the external detail composite. For these reasons, it is recommended that external detail composite always be reported. Although the inconsistent reporting of external categories has been highlighted (Strikwerda-Brown et al., 2018), finer-grained analysis is not always warranted (e.g., Palombo, et al., 2018) and could introduce spurious findings if not handled carefully.

Endel Tulving boldly recognized the key component of the self in episodic memory, particularly the representation of the self as a continuous entity across time (Wheeler, Stuss, & Tulving, 1997). This model emphasized the recollection of spatiotemporally specific episodes as distinct from acontextual knowledge. Yet Tulving does not regard his theories as precious; he readily revised them when “Mother Nature” said so. Given his stature as an experimentalist, he is remarkably open to insights from real life, where theories derived from the laboratory can crumble. In this respect, the sharp episodic-semantic distinction required revision to accommodate instances where those boundaries blurred (Renoult et al., 2012). While we construe the present taxonomy of narrative details as an advancement over the original coarser categories, we also recognize, like Tulving, that such constructs are merely placeholders eventually to be supplanted by more advanced measures.

**5. Appendix: Scoring manual**

As stated in the original AI manual, semantic information can be integrated into an episodic recollection (and scored as an internal detail) if it becomes an integral aspect of the episode*: "Madrid is hot"* is semantic, but *"Madrid was hot when I was there"* is episodic. In general,

details that reflect a long-standing state of being or without a clear beginning or end are considered semantic.

In the below examples, we separated 3 types of personal semantics:
Autobiographical Facts (AF); Self Knowledge (SK); and Repeated Events (RE).

Scoring example 1

**Sem1** **Sem2**

It was a company out of New Bedford that was building and

**Ed-ext1** **Ed-ext2**

did the shelves and that, the rough carpenter work and then

**Ed-ext3** **Ed-ext4**

there was another company that came in and did the finish

**SK1**

work but they were all happy with my work and stuff and

**SK2** **AF1**

saw that I listened and stuff and I was a carpenter's helper

**RE1**

and I helped when they needed something and they could

**SK3** **SK4**

depend on me and the company really really liked me

**Rep1** **Rep2**

what I did and the work I did and stuff.

From this example of the original AI manual, we can see that external semantic details are often used to set the scene and provide background contextual information. The clause *"It was a company out of New Bedford that was building"* contains two general semantic details, *a company building* and *New Bedford*. These knowledge details are presumably shared with

other people of the same environment (i.e., same city or neighborhood) and are thus categorized as general rather than personal semantics. In contrast, the rest of the paragraph contains personal semantic details. Some of these concern description of personal characteristics of the narrator – self-knowledge- (*they were all happy with my work*; *Saw that I listened and stuff; The company really really liked me)* that have a clear subjective component, as well as some more objective personal factual information – autobiographical facts-, like bits of one's CV *(I was a carpenter's helper)* and some description of extended or repeated personal events *(I helped when they needed something).* All of these are categorized as personal semantic details due to their personal and idiosyncratic nature.

In this transcript, the *shelves* and *carpenter work* were scored as external event details, because they are episodic events with clear beginning and endings (but not part of the defined internal event). Similarly, another company "coming in" was scored as an episodic detail (external) because it implies a discrete happening, as is *doing the finish work*.

Scoring example 2

**AF1** **AF2**

Well it was the first time… I'm Portuguese, my parents are from

**AF3**

Portugal, and it was the first time that I had gone there that

**AF4**

I can remember, so it would be the first time that I got to see

**AF5**

family that was over there and see a different way of living,

**Sem1**

because it was very old fashioned over there. It doesn't matter

**Other**

how old you are so it was just an experience.

**Sem2**

They have a lot of bull fights in the streets, which was

**Sem3**

interesting because you don't see that here, and even though my

**AF6**

parents are from there we never knew about that so that was…

**Ed-int1** **Place-int** **Ed-int2**

They released the bull right into the street tied to a rope and

**Ed-int3** **Ed-int4** **Ed-int5**

then all these men would go and they'd chase it and taunt it and

**Ed-int6**

the bull tried to attack them.

In this transcript, most clauses of the first paragraph were scored as personals semantics as they are autobiographical facts and not culturally-shared. As noted by Grilli and Verfaellie (2016), some of these autobiographical facts are experience-near and include spatio-temporal contextual information (*It was the first time that I had gone there*), while others are experience-far and more abstract (e.g., *I am Portuguese* and *my parents are from Portugal*). The experience-near autobiographical facts here were not scored as repeated events, as they appear to refer to a unique instance (e.g., *It would be the first time that I got to see family that was over there*).

*It was very old fashion there* was scored as general semantic, as we assumed that this would have been a general factual observation that could be shared with members of the relevant cultural group (i.e., Canadians visiting a small Portuguese village for the first time). However,

when the scorer judges that the narrator is giving a personal opinion, or expressing personal preferences ("Living there was dull"), they should score relevant details as personal semantics (as a type of self-knowledge). Judging whether the narrator expresses a general, culturally-shared fact or a personal opinion is sometimes a judgement call and, as expressed in the main AI manual, scorers will be somewhat influenced by their own knowledge and experience with the subject matter.

In the second paragraph, the clauses *They have a lot of bull fights in the street* and *You don't see that here* were scored as general semantics, as these details were judged to be culturally shared general factual information.

<u>Scoring example 3:</u>

**RE1**

We usually go to Jerry's house around Christmas time. And then

**RE2**

they invite people, their friends and relatives and it becomes

**RE3**

a very nice party. So it was enjoyable going there and then

**Ed-int1** **Ed-int2**

they had the lunch that time. This time they had it as tables.

**Perc-int** **Ed-int3**

They had four or five tables. There was one person who was

**Ed-int4**

the person who invited us. She said, why are you at that

**Ed-int5**

table, why are some people at that table and I'm at the other

**AF1**

table? She is in her 30's but… so I merely said to her, well

**Ed-int6**
you can sit there.

In this transcript, the three first clauses of the first paragraph were scored as personals semantics as they are memories of repeated events (i.e., the narrator is reporting usual Christmas party arrangements), and are not culturally-shared. The clause *She is in her 30's* was scored an autobiographical fact, as it reflects non-culturally shared knowledge.

In contrast, the rest of the paragraph describes a unique instance with a number of internal details that the participant is presumably re-experiencing as an episodic memory.

**Some rules for assigning detail categories when in doubt**

When in doubt between 2 categories, we suggest that the latter of each possible pairs below gets precedence.

**GS versus various types of personal semantics:**

Knowledge details that are presumably shared with other people of the same environment (e.g., same country, city or neighborhood, depending on what is relevant in the context) are categorized as general rather than personal semantics. However, when in doubt for a particular detail between general and personal semantics (as in the three possible cases listed below), we suggest that this particular detail should be scored as personal semantics. This is in line with the current instructions of the AI that invites participants to retrieve personal rather than general memories.

**GS vs AF:**

It can sometimes be difficult to decide whether certain aspects of knowledge can reasonably be considered to be shared with other people of the same environment (GS) or personal (AF). For example, the clauses *"It is actually where they live*" and *"The house is appreciably larger than their previous one*" would both be scored as AF, as we would assume that these do not constitute factual information that is necessarily shared with other members of the community (i.e., neighborhood in this case).

Similarly, knowledge of people is often multi-dimensional. We classify knowledge about famous people as GS (i.e., culturally-shared), and knowledge of people that are personal acquaintances or family members as AF. Finally, knowledge of oneself and personality traits is classified as SK (see below and Table 2).

**GS vs SK**

As stated for scoring example 2 above, personal opinions or preferences ("*Living there was dull*") should be scored as SK, not GS.

Classifying **GS vs RE** should generally be straightforward. GS can refer to multiple instances *("Children used to go to school on Saturday morning")* but only RE is personal in content *("I used to go to school on Saturday morning")*. Again, when in doubt, we recommend to classify relevant details as personal semantics (i.e., RE in this case).

**Differentiating subtypes of personal semantics:**

**SK vs. AF:**

As stated above, knowledge of oneself, personal preferences *("I love chicken*"), internal states and personality traits *("I am persistent")* is scored as SK rather than AF. In contrast, basic personal information that is objective and *not* directly applied to core self (traits and personality) is scored as AF rather than SK *("My brother's name is Michel"; "I lived on Broke street")*. SK also includes personal opinions and judgements about self *("I enjoyed swimming"*) and others *("They are nice kids"*). One way to differentiate SK from AF (and the subjective versus objective nature of a detail) rests on whether or not another person upon seeing the same behavior would arrive at the same conclusion: if this is the case, the

relevant detail should presumably be scored as AF. If in doubt between SK and AF, we suggest to score as AF.

**AF vs. RE**: Both experience-near AF *("It was the first time that I had gone there")* and memories of repeated events *("We usually went to Jerry's house around Christmas time")* can include spatial and temporal context elements, but should be scored in term of whether one thinks that the narrator is referring to a particular time (AF) or to multiple instances (RE). Separating RE from experience-far AF ("I lived there during my childhood") is generally much more straightforward, as these AF are more abstract and do not include temporal and spatial information.

Negative statements that refer to something that did not take place, such as *"I never used to take the subway",* are generally scored as AF rather than RE, as we assume that it cannot be considered as a repeated event if it never happened.

Finally, as mentioned above, whereas memories of repeated events are personal in content ("*e.g., "I was going to the grocery store every week while I lived in Europe"),* autobiographical facts do not necessarily concern the self and include knowledge about personal acquaintances and close-others *(e.g., "My friend Bob goes to the grocery store every week"*; see Table 2*).* So non-personal repeated events are not classified as RE, but as AF as above, or as GF if we assume that the repeated statement expresses knowledge that is culturally shared.

If in doubt between RE and AF, we suggest to score the detail as RE, consistent with the AI manual that recommends to score as an event when in doubt.

**SK vs. RE**

Finally, distinguishing this last possible combination should most often be obvious For example, in scoring example 1 above, we reasoned that the clause *"the company really really liked me"* reflected a subjective evaluation of how the narrator thinks he/she is loved, rather than a memory of a repeated event. However, if in doubt between SK and RE, we suggest to score as RE for the reason just mentioned.

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