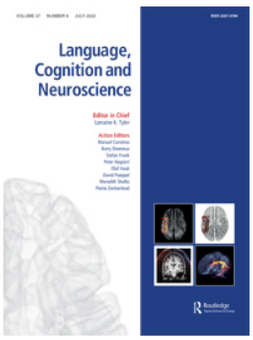

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REGULAR ARTICLE

Conceptual retrieval for unique entities does not require proper names

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ABSTRACT

When asked to describe unique entities by providing specific, identifying information, people typically include proper names for other, related concepts (e.g. song titles when describing a musician). Here, we investigated whether proper names are *necessary* to accurately describe famous persons and places. Participants (healthy adults, $N = 39$) were shown names of famous persons or landmarks and asked to provide uniquely-identifying information about each, *without* using proper nouns. Their performance was compared to individuals who were unrestricted in proper noun use in this task. The current participants, who were prevented from using proper names, performed similarly to comparison participants who could use proper names. Additionally, the current participants performed significantly better than participants with damage to the left temporal pole (who have impaired proper noun retrieval due to their brain damage). These findings indicate that retrieval of proper nouns is not necessary to correctly identify and define semantically unique entities.

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Naming; concepts; recognition; anterior temporal lobe

Conceptual knowledge for semantically unique entities (i.e. items that are denoted with a proper name) is commonly assessed using a verbal descriptive task: That is, participants are presented with the name or picture of a unique entity and asked to describe that entity by providing specific, uniquely-identifying information. For example, individuals may be presented with the name of a person (e.g. "Michael Jackson") or place (e.g. "Big Ben") and be asked to identify and define each. Responses are considered "correct" if the description is specific enough such that the target item can be identified based on the description alone. For example, a "correct" description for Michael Jackson might be "Performed in the Jackson 5 and later as a solo artist. Wore a white glove and did the moonwalk. Performed the songs 'Thriller' and 'Beat It;'" while a correct description of Big Ben might be: "A famous clock tower, part of Westminster Palace in London, England". We have noticed in prior work that many correct responses on this type of task include other proper names (Schneider et al., 2018; Tranel, 2006). For example, accurate conceptual retrieval for a musical artist could include retrieving the names of specific songs they performed (e.g. stating "Sang the songs 'Thriller' and 'Billie Jean'" in response to the stimulus "Michael Jackson") or other related persons (e.g. "Brother of Janet Jackson"). This raises an interesting question: If the use of proper names in identifying/defining a unique person or place is prohibited, would this adversely affect the ability to identify/define persons and places? This question is the focus of the current study.

While a substantial portion of prior work on this topic uses a "recognition-from-name" paradigm, other research has taken the converse approach, by providing participants with descriptions of entities and asking for a name. For example, such descriptive cues used in prior work include "Redhead that Desi Arnaz loved" (Lucille Ball), "Ginger Rogers' dance partner" (Fred Astaire), and "Sang with Sonny Bono" (Cher; Hammeke et al., 2005). These examples, which are essentially short definitions of famous persons, all include proper names of other, related concepts. Typically in these tasks, healthy participants perform quite well, both when providing conceptual information when given a name (Schneider et al., 2018) and providing a name when given conceptual information (Hammeke et al., 2005). One question that arises when looking both at (1) the responses given on the descriptive task and (2) the cues used for the naming task, is: Are proper names for related concepts *necessary* in order to accurately identify unique entities?

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Here, we sought to test this question: If participants are restricted such that they cannot use proper nouns when describing unique entities, do they not perform with high levels of accuracy on this task?

This question takes on particular significance in the context of the neuropsychological literature, which has used such tasks to investigate the role of the anterior temporal lobes in retrieval of conceptual knowledge for semantically unique items. A long history of neuropsychological work implicates the left temporal pole (LTP) as a critical structure for naming semantically unique entities. Individuals with damage to the LTP are impaired at naming unique entities including famous landmarks (Tranel, 2006), faces (Borghesani et al., 2019; Busigny & Boissezon, 2015; Damasio et al., 1996; Drane et al., 2008; Rice et al., 2018), voices (Papagno et al., 2017; Waldron et al., 2014), and melodies (Ayotte et al., 2000; Belfi et al., 2019; Belfi & Tranel, 2014; Johnson et al., 2011). Persons with LTP damage are also impaired at retrieving names when given a verbal description of a unique entity (e.g. retrieving "Elvis Presley" when given "The hound dog king of rock and roll"; Hammeke et al., 2005; Swanson et al., 2020). Functional imaging, neurophysiological, and neurostimulation research complement these findings, further confirming the role of the LTP in naming unique entities (Abel et al., 2015; Gorno-Tempini et al., 1998; Grabowski et al., 2000; Pisoni et al., 2020; Ross & Olson, 2012). Additionally, it has been shown that stimulating the left anterior temporal lobe disrupts confrontation naming (Pisoni et al., 2020; Woollams et al., 2017). Taken together, substantial evidence supports the theory that the LTP serves as a heteromodal region (i.e. regardless of the sensory modality of the stimulus) critical for binding a unique item's name with conceptual knowledge about that item.

One long-standing theory has posited that the LTP is a "convergence zone" which plays a *bidirectional* role in mediating the relationship between lexical and semantic information about unique entities (Damasio et al., 2004). Newer theories have broadened the role of the bilateral anterior temporal lobes as transmodal "hubs" for semantic information. Original "distributed-plus-hub" models posited that the ATL serves as a "hub" which integrates information from distributed systems which individually contain information about a concept in various sensory modalities (Patterson et al., 2007). Most recently, this type of "hub-and-spoke" model has been expanded to include regions involved in semantic control processes (Lambon Ralph et al., 2017). Whether a convergence zone for semantically unique items or a singular hub, the commonality across these theories is that they suggest that damage to the anterior temporal lobes would result in impairments in semantic retrieval from names. That is, not only would individuals with LTP damage be impaired at retrieving names when given conceptual information about entities (e.g. pictures or descriptions of famous persons), but the deficit would also be apparent in the opposite "stimulus-response" pattern: That individuals with LTP damage would be impaired at providing conceptual information when given an entity's name.

Our recent work used this type of "recognition-from-name" paradigm in individuals with damage to the LTP (Schneider et al., 2018). In this task, participants viewed the names of unique entities, written out on a screen, (e.g. "Marilyn Monroe") and were asked to provide uniquely-identifying conceptual information about each entity (e.g. "She was a famous blonde actress in the 50's. Well known for the photograph of her standing over a vent blowing up her skirt. She died of an overdose. Married to Joe DiMaggio briefly".). We found that, in comparison to healthy adults and individuals with brain damage outside the LTP, persons with LTP damage were significantly impaired at retrieving conceptual information for famous persons and landmarks (Schneider et al., 2018). This work is complemented by similar studies in individuals with neurodegenerative disorders affecting the anterior temporal lobes, including semantic dementia and primary progressive aphasia. Persons with these disorders who have disproportionate atrophy in the left ATL, have impairments in conceptual retrieval when given pictures (Gefen et al., 2013) or names of famous persons (Snowden et al., 2004, 2012), famous brands (Macoir et al., 2020), and everyday objects (Mesulam et al., 2013). Additionally, individuals with left-hemisphere ATL damage due to primary progressive aphasia show semantic retrieval impairments even in non-verbal tasks, such as associating famous faces with other related persons (Borghesani et al., 2019) and matching musical excerpts to semantic concepts (Macoir et al., 2016).

Collectively, this evidence indicates that individuals with LTP damage exhibit both defective proper name retrieval when given a unique concept (e.g. a picture of Marilyn Monroe) and defective concept retrieval when given a proper name (e.g. the name "Marilyn Monroe"). However, this does not definitively answer whether these "name-to-concept" deficits are due to true impairments in conceptual retrieval. One possible explanation for the two-way deficit is that retrieval of conceptual knowledge for unique entities requires retrieval of proper names for related concepts. The fact that individuals with LTP damage have difficulties with proper name retrieval could therefore explain the proposed "bidirectional effect" shown in prior work. That is, a person with LTP damage may simply *appear* to

have impaired conceptual retrieval, because they struggled to produce proper names of associated items, rather than a true deficit in conceptual knowledge retrieval. This potential explanation confounds the interpretation that they have a true, underlying deficit in conceptual knowledge retrieval for unique entities. Thus, impaired proper name retrieval in individuals with LTP damage may be the mechanism underlying their observed impairments in defining unique entities when given a name.

The present study sought to clarify this question by investigating whether proper names are necessary for correctly identifying and defining unique entities (in a verbal paradigm). If healthy participants are not allowed to use proper nouns in their responses, can they still provide specific, identifying information for semantically unique items? Here, neurologically healthy participants were presented with the names of famous persons and landmarks and were asked to provide uniquely-identifying information about each entity. The key design feature in the current study, as compared to prior work, is that participants were explicitly instructed *not* to use any proper names in their descriptions.

To answer the question of whether preventing the use of proper nouns has an adverse effect, we compared data from the current participants to participants from a prior study who were not restricted from using proper nouns (Schneider et al., 2018). We made two contrasts: First, the current data were compared to data from a group of comparison participants who performed normally on the task when unrestricted in their proper noun use. Second, the current data were compared to data from a group of individuals with LTP damage, who were impaired on this task. If using proper names of related concepts is necessary to correctly identify unique entities, we would expect the current participants to perform similarly to the LTP group. That is, by eliminating the ability to use proper nouns, healthy adults may perform similarly to persons with LTP damage (who are restricted in proper name use due to the effects of their brain damage). In contrast, if proper names are not necessary to identify unique entities, we would expect participants in the current study to perform this task at the same level as comparison participants who are unrestricted in their use of proper names.

Method

Participants

We selected our target number of participants based on our prior research using a similar task (Schneider et al., 2018). This prior study identified a very large effect size ($\eta^2 = 0.28$) resulting from an ANOVA comparing conceptual retrieval scores on both faces and landmarks across three participant groups: individuals with LTP damage, healthy comparisons, and brain-damaged comparisons. That is, there was a large effect indicating that participants with LTP damage scored significantly lower on conceptual retrieval than the other two participant groups. Using this effect size, we conducted an a priori power analysis using G*Power software (Faul et al., 2007), which indicated that a sample size of 13 participants per group would be adequate to detect an effect of this size. To account for some degree of data loss given this was an online study, we sought to recruit 22 participants per group. Participants were recruited online using Prolific, an online platform for recruiting participants for experiments. Participation was restricted to participants in the United States who are native English speakers and had at least a 90% approval rate on Prolific. To match the age range of our data from the previous experiment, participants were required to be between the ages of 40–70.

To minimise participant fatigue, participants were assigned to one of two conditions: Famous Persons or Famous Landmarks. In the persons condition, 22 participants completed the study. Two participants were excluded for not following directions (one for writing nonsensical responses, and one for using proper names in most of their responses). This proportion of inattentive participants is typical for online studies (Meade & Craig, 2012). Therefore, 20 participants (7 M, 13 F) were included in the final group. Participants in the persons condition were, on average, 54.95 years old (SD = 10.41) and had 16.0 years of education (SD = 3.22). In the landmarks condition, 22 participants completed the study. Two participants were excluded for not following directions (as in the persons condition, one for writing nonsensical responses, and one for using proper names in most of their responses), and one participant was excluded for not meeting the inclusion criteria (their self-reported age was below the cutoff range). Therefore, 19 participants (8 M, 11 F) were included in the final group. Participants in the landmarks condition were, on average, 54.26 years old (SD = 8.69) and had 16.21 years of education (SD = 2.50)

Materials

Two categories of unique entities were used in this experiment: famous persons and famous landmarks. Stimuli were taken from prior work (Schneider et al., 2018). Stimuli consisted of the *names* of famous persons and landmarks (not pictures of the entities).

There were 26 names of famous persons and 20 names of famous landmarks. Full stimulus lists can be found with the full dataset from the present study, which is posted in the following OSF repository: https://osf.io/aqbn4/.

Procedure

Participants provided informed consent before participating and all procedures were approved by the Institutional Review Board of the University of Missouri. Procedures followed our prior work closely (Schneider et al., 2018). On each trial, the name of the item (either person or landmark) was shown on the screen. First, participants rated their familiarity with the entity on a six-point scale, with one being 'Unfamiliar, completely sure' and six being 'Familiar, completely sure'. If the participant rated their familiarity at 3 or below, this indicates that the participant was not familiar with the item. If this was the case, then the trial ended and they were presented with the next stimulus. This type of scale has been used in our previous work (Belfi & Tranel, 2014; Schneider et al., 2018) and is modelled on scales used to identify familiarity with faces in individuals with prosopagnosia (Tranel & Damasio, 1988). If the participant rated their familiarity at a 4 or above, they proceeded with the following question: Participants were asked to "Please describe the person [landmark] without using any proper nouns. Remember to be as specific as possible and provide uniquely identifying information for this particular person [landmark]". They were shown a text box in which to type their responses. After participants were finished typing their description, they continued to the next trial until they completed all stimuli (either persons or landmarks).

Data quantification

Scoring was done as in previous work (Schneider et al., 2018). Trials were scored as "correct" if two independent raters were able to correctly guess the name of the item given the participant's description. If both raters correctly guessed the item, it was scored "1" for correct; if both raters failed to identify the item, it was scored "0" for incorrect. If the raters were split (which happened on fewer than 10% of trials), they discussed their ratings and came to a consensus. An example of a "correct" response for Steven Spielberg was: "A famous director. One of his earliest and famous movies dealt with an alien who wanted to go home". An example of an "incorrect" response for Steven Spielberg was: "Famous director and screenwriter/producer". After scoring each trial, we then calculated an overall score for each participant. To obtain the overall conceptual retrieval score, we divided the total number of correct trials over the total number of items on which retrieval was attempted (that is, the number of trials on which participants rated the stimuli as 4 or higher on the familiarity scale). This was to not penalise participants on items with which they were not familiar.

Comparison data

We compared data from the present study to previously collected data using the same task (Schneider et al., 2018). In this previous study, participants completed the same task described here but were not restricted in their use of proper nouns. Participant groups consisted of individuals with damage to the left temporal pole (LTP; $n = 8$); and a comparison group (CG; $n = 37$) consisting of both healthy and brain-damaged participants (who had damage outside of the temporal lobes) who are known to perform normally on this task. One difference between the two studies was that the prior study was conducted in a lab setting, in person, while the present study was conducted online. In the present study, participants typed their responses on a keyboard, while in the previous study, participants provided verbal responses which were audio recorded and later transcribed for scoring. Another difference was that in our prior work, participants were prompted by the experimenter to provide additional information if they initially struggled to retrieve information or provided a very vague response, whereas participants were given no additional prompting in the online task.

Analysis

All analyses were conducted using R (*v*3.6.2). For both faces and landmarks, we conducted a generalised linear mixed effects model using the glmer function from the lme4 package (Bates et al., 2015) to compare the current participants' conceptual retrieval scores (we refer to the current group as the "New" group) to CG and LTP participants from previously collected data (Schneider et al., 2018). In these models, group (New, CG, LTP) was included as a fixed factor, with random intercepts for participants and stimuli. Since "group" is a categorical predictor with four levels, we used treatment contrasts which were dummy coded using the data from the new participants as the reference group. Data for persons and landmarks were analyzed separately since two different groups of participants completed the two stimulus categories.

Results

First, we looked at the familiarity rates (i.e. the number of trials participants rated higher than a "3" on the familiarity scale). For persons, the average number of familiar stimuli was 21.7 out of 26 stimuli (SD = 5.39, min = 12, max = 26). For landmarks, the average number of familiar stimuli was 14.3 out of 20 stimuli (SD = 4.20, min = 7, max = 20). In our prior work, participants were excluded who were familiar with fewer than 30% of the stimuli, in order to eliminate participants whose recognition scores were so low that it would confound the interpretation of their conceptual retrieval scores (Tranel, 2006). No participants in the present study fell below this threshold.

For famous persons, our model revealed a significant difference in conceptual retrieval scores between the LTP group and the new participants ($\beta = -2.02$, SE = 0.64, $z = -3.14$, $p < 0.001$) but no difference between the new participants and the CG ($\beta = 0.08$, SE = 0.44, $z = 0.17$, $p = 0.87$) (see Figure 1(A)). For famous landmarks, our model revealed a significant difference in conceptual retrieval scores between the LTP group and the new participants ($\beta = -1.91$, SE = 0.75, $z = -2.55$, $p = 0.01$) but no difference between the new participants and the CG ($\beta = 0.20$, SE = 0.53, $z = 0.83$, $p = 0.70$) (see Figure 1(B)).

Discussion

The present study sought to investigate whether proper name retrieval is necessary for correct conceptual identification of semantically unique entities. To do this, neurologically healthy adult participants were presented with the names of famous persons and famous landmarks. After each name, participants were asked to describe the entity in as much detail as possible, with one caveat – that their descriptions could not use any proper nouns. If proper name retrieval is *required* for accurate conceptual retrieval, we would have expected to see a decrease in accuracy when participants were unable to use proper nouns. However, the data from the current study indicate that even when restricted from using proper nouns, healthy participants are able to provide uniquely-identifying information about semantically unique entities. When we compared the data from the current participants to data from a previous study in which participants were *not* restricted in the ability to use proper nouns, the results were highly similar – there were no differences in the conceptual retrieval accuracy for healthy individuals who could or could not use proper nouns in their descriptions.

The present results also have potential implications for the mechanism underlying conceptual retrieval deficits in persons with LTP damage. Our prior work

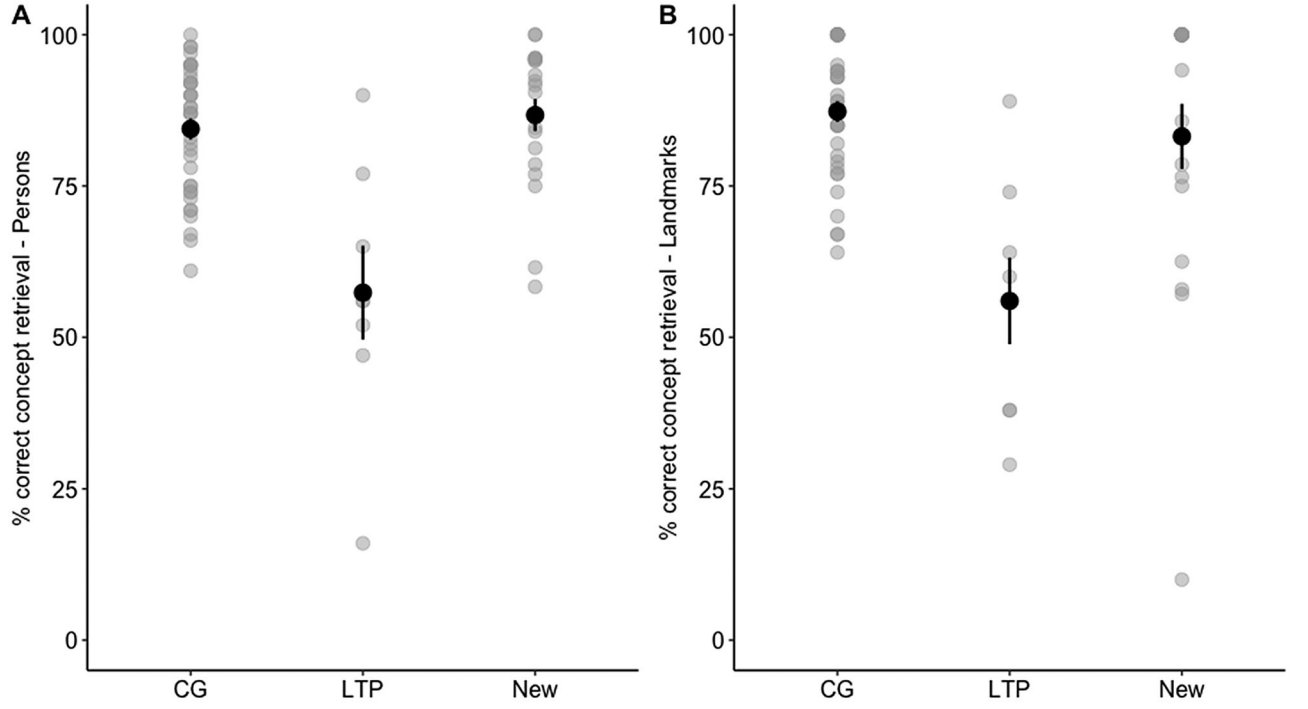

Figure 1. Conceptual retrieval data for (A) Persons and (B) Landmarks. CG = Comparison Group; LTP = Left Temporal Pole; New = New participants (participants in the current study). Transparent grey points indicate individual subject data. Darker grey dots illustrate overlapping participants. Opaque black points indicate group means; error bars indicate standard error of the mean.

identified that persons with LTP damage are impaired at providing conceptual information about unique entities when given a name (Schneider et al., 2018). However, it was not clear whether this impairment was due to a true deficit in conceptual retrieval for unique entities, or whether it was due to deficits in proper name retrieval for related concepts. Here, our results help clarify whether observed deficits in conceptual retrieval in persons with LTP damage could be due simply to impairments in proper name retrieval for semantically related concepts. By comparing our new data to that of persons with LTP damage, our results shed some light onto this issue: These results suggest that deficits in proper name retrieval of related concepts *alone* would likely not lead to deficient performance on the current task. When restricted from using proper nouns, healthy individuals still can perform this task with a high level of accuracy. This suggests that the reason why individuals with LTP damage perform poorly on this task is likely not due to proper naming deficits alone. Instead, we suggest that individuals with LTP damage have impairment in a third-party broker mechanism mediating between lexical and semantic knowledge of semantically unique items. It is also important to note that we do not suggest that LTP damage results in a complete multimodal semantic impairment – it is not that the semantic knowledge is entirely destroyed, but that damage to the LTP results in deficits in *name-concept* mapping.

Of course, this work is not without limitations. For one, the data collection method for the present study was not identical to that of the comparison data. Specifically, the present dataset was collected entirely online, and participants typed their responses into a text box, while the comparison dataset was collected in person and participants gave verbal responses. However, we would expect that the online data collection method would only *lower* the accuracy of the current participants, and therefore would be working in opposition to the effect we found. Despite these differences, we still see that the LTP group performed significantly worse on this task than the new, online participants. Even though participants in the LTP group were given additional advantages beyond the online participants (i.e. were given additional prompting from an experimenter) their performance was still below the new healthy participant group.

Another limitation of the present work is we used a standard but relatively minimal scoring method for the present dataset (i.e. scoring 0 for incorrect and 1 for correct recognition). We used this scoring method to align the present data with the previous dataset to which we compare our current work. However, to further elaborate on the nature of how restricting proper nouns would influence conceptual retrieval scores, future research could use a more fine-grained scoring procedure. An additional interesting direction for future work would be to conduct the present study in a within-subjects manner. Here, we compared data on our new task (i.e. conceptual retrieval without the use of proper nouns) to participants who completed a similar task without proper noun restrictions. However, an alternative strategy would be to have participants complete half of the study with proper nouns and half without, and compare the results within-subjects.

A final important aspect to acknowledge about the present study is that the task used here relies entirely on verbal inputs (i.e. names) and outputs (i.e. spoken or typed text). While this is not specific to our work, it is an important limitation. That said, the goal of the present study was to investigate one component of the verbal nature of this task: When asked to verbally describe unique concepts, is it necessary to rely on proper names of other, related concepts? While other, non-verbal tasks should be used to complement these results, the present study sought specifically to test a question about the verbal descriptions participants provide when given the name of an item. Furthermore, we think these results have important implications for communication in general: In the "real world" such verbal communication is critical, where individuals call one another by name, speak, and write messages using words (including proper names). While nonverbal identification of concepts is another important component of conceptual knowledge, the verbal aspects of identification are also critical for understanding how individuals describe, identify, and communicate about concepts.

To conclude, the study reported here indicates that use of proper nouns is not necessary for correct identification of semantically unique items (i.e. persons and places). In prior work, when asked to describe famous persons and places, participants typically gave descriptions which included proper names for semantically related concepts – for example, stating the names of pertinent films when asked to describe an actor. However, as we found here, participants who were prohibited from using proper nouns did not fail this task. Instead, they were able to provide specific, accurate descriptions, including uniquely-identifying information, without using proper nouns. These results also have implications for the theory that the LTP is a critical region mediating lexical and conceptual knowledge of unique entities. Prior work has shown that persons with LTP damage are unable to correctly describe semantically unique items when given a proper name.

However, it was not known whether their failure on this task was due to a true deficit in concept retrieval or merely issues with retrieving proper names. Here, we found that retrieval of proper names is not required for accurate conceptual retrieval, which suggests that proper name retrieval deficits alone cannot account for the deficits in persons with LTP damage. It would follow that the LTP damage is interfering with the operation of convergence regions that broker between proper names and conceptual knowledge. In sum, these results provide support for our theory that individuals with LTP damage are impaired on this task due to a disrupted brokering mechanism between the names and conceptual knowledge for unique entities.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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