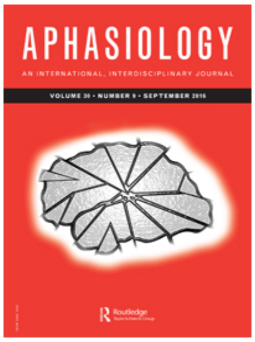

Aphasiology

ISSN: 0268-7038 (Print) 1464-5041 (Online) Journal homepage: http://www.tandfonline.com/loi/paph20

Semantic knowledge use in discourse produced by individuals with anomic aphasia

Stephen Kintz, Heather Harris Wright & Gerasimos Fergadiotis

Aphasiology, 2016
Vol. 30, No. 9, 1012–1025, http://dx.doi.org/10.1080/02687038.2015.1081140

Semantic knowledge use in discourse produced by individuals with anomic aphasia

Stephen Kintz[a]*, Heather Harris Wright[a], and Gerasimos Fergadiotis[b]

[a]*Department of Communication Sciences and Disorders, College of Allied Health Sciences, East Carolina University, Greenville, NC 27834, USA;* [b]*Portland State University, Portland, OR 97201, USA*

(*Received 18 February 2015; accepted 5 August 2015*)

Background: Researchers have demonstrated that people with aphasia (PWA) have preserved semantic knowledge. However, some PWA have impaired access to certain types of knowledge more than others. Yet, all these studies used single concepts. It has not been demonstrated whether PWA have difficulty accessing certain types of features within a discourse sample.
Aims: The main goals of this study were to determine whether semantic knowledge and two category types were used differently within discourse produced by participants with anomic aphasia and healthy controls.
Methods & Procedures: Participants with anomic aphasia (n = 19) and healthy controls (n = 19) told stories that were transcribed and coded for 10 types of semantic knowledge and two category types, living and non-living things.
Outcomes & Results: A Poisson regression model was conducted. The results indicated a significant difference between the groups for the semantic knowledge types, *sound* and *internal state*, but no difference was found for category types. Yet the distribution of semantic knowledge and category types produced within the discourse samples were similar between the groups.
Conclusions: PWA might have differential access to certain types of semantic knowledge within discourse production, but it does not rise to the level of categorical deficits. These findings extend single-concept research into the realm of discourse.

Keywords: semantic features; anomic aphasia; discourse

Introduction

Semantic memory is a type of long-term memory that stores knowledge, facts, and beliefs about concepts and words that is not tied to a specific episode in an individual's life and can be accessed from multiple modalities (e.g., verbally or visually). Semantic knowledge refers to the knowledge, facts, and beliefs about concepts and words stored in semantic memory (Lambon Ralph, 2014). Semantic representations refer to the knowledge stored about a distinct concept or word that can be accessed through multiple modalities (Martin, 2001). Concepts and words are stored in semantic memory and have semantic representations made up of semantic knowledge. Therefore, when a person hears the word *dog* or sees a picture of a *dog*, the representations are, at least, partially activated and contain the knowledge about that particular concept. Semantic knowledge is made up of modality-specific features that are the building blocks of concepts (Lambon Ralph, 2014). It should be noted that features are not the only type of semantic knowledge, but features may be the most studied type of semantic knowledge. For an example of features, consider a *red*

*Corresponding author. Email: kintzcc@gmail.com

ball, which has a specific shape, *sphere*, and colour, *red*. The shape and colour of the ball are its features. Researchers classify features in a number of different ways. Mason-Baughman and Wallace (2014) classified features based on how distinctive the features were in identifying concepts. Features that are generally associated with only one concept (e.g., a trunk of an elephant) are considered more distinctive than features common to multiple animals (e.g., has four legs).Warrington and McCarthy (1987) classified features based on whether they were sensory or functional. Sensory features would include knowledge about a concept obtained from an individual's senses. Functional features would include knowledge on how the individual uses and interacts with concepts. Cree and McRae (2003) expanded the sensory-functional classification system by grouping features into several macro-scale knowledge types based on distinct brain regions hypothesised to process modality-specific knowledge. The researchers included nine semantic knowledge types: (a) *colour*, (b) *encyclopaedic*, (c) *function*, (d) *motion*, (e) *sound*, (f) *smell*, (g) *tactile*, (h) *taste*, and (i) *visual parts and surface*. For example, the words *go, walk*, or *run* would possess features associated with the knowledge type, *motion*.

For people with aphasia (PWA), the core deficit of anomia is not attributed to a degradation of semantic knowledge but an inability to access and control semantic knowledge (Dell, Schwartz, Martin, Saffran, & Gagnon, 1997; Goodglass & Wingfield, 1997; Noonan, Garrard, Jefferies, Eshan, & Lampon Ralph, 2013; Noonan, Jefferies, Corbett, & Lambon Ralph, 2009; Schwartz, Dell, Martin, Gahl, & Sobel, 2006). This may present as a differential access to certain types of features (Antonucci, 2014; Marques, Mares, Martins, & Martins, 2013; Mason-Baughman & Wallace, 2014; Thompson & Jefferies, 2013). To date, researchers have not investigated whether modality-specific features differ in PWA and healthy controls, and while several researchers have examined how semantic feature-based treatment influences discourse (Boyle, 2004; Peach & Reuter, 2010; Rider, Wright, Marshall, & Page, 2008), none have investigated how semantic knowledge types are used within discourse.

Researchers generally agree that the semantic impairments in PWA are not related to the degradation of semantic representations but, instead, are an impairment in semantic control (Jefferies & Lambon Ralph, 2006; Jefferies, Patterson, & Ralph, 2008; Jefferies, Rogers, Hopper, & Lambon Ralph, 2010; Noonan et al., 2009, 2013). Jefferies and Lambon Ralph (2006) demonstrated that PWA have preserved semantic representations but impaired lexical access by comparing 10 participants with a range of different aphasia types (e.g., anomic, conduction, global, mixed, and transcortical sensory) to 10 participants with semantic dementia (SD). The participants completed a range of neuropsychological assessments (e.g., executive function and memory tests) and semantic memory assessments, such as the Pyramids and Palm Trees Test (Howard & Patterson, 1992) and Boston Naming Test (BNT; Kaplan, Goodglass, & Weintraub, 2001) using multiple input modalities. PWA performed considerably better when provided a phonemic cue on the BNT. Participants with SD performance did not improve with phonemic cues. These results, which have been replicated (Jefferies et al., 2008), demonstrate that PWA have preserved semantic representations but difficulty using lexical information to retrieve semantic representations. Further, the types of errors produced by PWA implicate degraded semantic control in selecting the lemma forms. On the same items, PWA performed inconsistently across different tasks that require different levels of executive control, and PWA produced more associative errors than the SD group. These results most likely occurred because highly related semantic features activate words with similar or associated feature networks.

Other researchers have found that PWA produced less regularisation errors compared to participants with SD (Jefferies et al., 2010), had poor inhibition of associated distractors (Noonan et al., 2009), and exhibited a reserve effect for familiarity (Noonan et al., 2013). Regularisation errors occur when a participant produces an irregular form, such as *spoke*, as a regular word form, such as *speak-ed*. Jefferies et al. (2010) explains that in aphasia, as compared with SD, semantic representations provide support for the irregular word form. Therefore, PWA produce fewer regularisation errors than participants with SD, who do have a loss of semantic knowledge. Poor inhibition of distractors occurs when an associated word, such as *dog*, is activated and produced instead of the target item, such as *cat*. Associated errors cannot be explained by a loss of semantic knowledge since a loss of knowledge would result in less activation of related and associated forms. Moreover, participants with SD almost never produce these errors (Noonan et al., 2009). The reserve effect for familiarity occurs when PWA produce a less familiar term compared to a more familiar term. For example, a PWA might produce the word *coin or dollars* when the more frequently used term *money* is a better fit.

While these previous studies suggest that semantic knowledge is preserved in PWA, several researchers have demonstrated impairments in accessing certain types of features (Antonucci, 2014; Marques et al., 2013; Mason-Baughman & Wallace, 2014; Thompson & Jefferies, 2013). Researchers who have examined semantic access in aphasia have demonstrated that PWA may present with deregulation in a single modality (Thompson & Jefferies, 2013), superordinate categorical deficits (Marques et al., 2013), and feature processing differences (Antonucci, 2014; Mason-Baughman & Wallace, 2014). Mason-Baughman and Wallace (2014) investigated the role of two types of semantic features (common and distinctive) and three levels of feature importance in recognising the target concept (high, medium, and low). The study included 10 PWA who had unilateral left hemisphere lesions and belonged to one of two groups: (a) able to choose among semantically related foils or (b) had difficulty choosing among semantically related foils. The study consisted of a series of semantic assessments that included an unrelated semantic foils task, a feature sorting task, and a related semantic foils task. Results indicated that the group that performed poorly on the semantically related foils task had difficulty processing distinctive features with low importance. The researchers concluded that distinctive features with low importance are not reliably accessible by some PWA. The findings support Marques et al. (2013), who found that six PWA with unilateral left hemisphere lesions had difficulty processing distinct features in a true/false sentence task compared with 12 healthy controls. The researchers concluded that distinctive features are less accessible to PWA.

Since PWA may have reduced access to distinct features, it is possible that PWA may have reduced access to certain modality-specific features (i.e., sensory and functional features). Warrington and McCarthy (1987) argued for reduced access to certain types of semantic features to explain the category deficits found in a participant with severe global aphasia. The participant presented with a category deficit for non-living things. The researchers argued that living things possessed more sensory features, while non-living things possessed more functional features. If true, this can explain why the participant had preserved recall for food items. Food items, unlike other non-living concepts, depend on sensory features more than functional features (Cree & McRae, 2003; Warrington & McCarthy, 1987). It is not known whether this reduced access to modality-specific semantic features extends to discourse.

Antonucci (2014) also examined the relationship between semantic features and concept categories. The study included 15 participants with aphasia (6 females). The participants had an age range between 42 and 82 years and an average educational attainment between 12 and 20 years. The study included a yes/no verification task that matched concrete living and non-living concepts with sensory and functional features. The researcher found PWA responded more accurately to non-living concepts than living concepts, along with functional features more accurately than sensory features. However, the difference between feature types and category types did not rise to the level of category deficits, and the researcher withheld drawing conclusions from the current study until future studies are conducted. Yet the inability to access certain features is problematic for two reasons: (a) an incomplete activation of features might result in more competition at the lemma level since more features can reduce the number of competing lexical items and (b) a reduction in certain features might result in reduced access to one or more categories of concepts (Warrington & McCarthy, 1987).

Most studies on semantic feature access and PWA focus on single-concept items. However, language is more often used for communication at the discourse level. Discourse is a cognitively difficult process that relies on linguistic processes (e.g., lexical access) and other cognitive processes to maintain coherence and monitor pragmatic criteria (Kintsch, 1994). These include working memory and higher-order organisation processes that organise and order stories (Ash et al., 2009). Researchers have not readily examined how semantic features are used within discourse, even though many researchers have examined how Semantic Feature-Based Treatment (Haarbauer-Krupa, Moser, Smith, Sullivan, & Szekeres, 1985) influences discourse (Boyle, 2004; Peach & Reuter, 2010; Rider et al., 2008). Armstrong (2001) examined the lexical categories of verbs in discourse samples given by four PWA and four healthy controls. Armstrong categorised verbs from personal recounts into one of five semantic-lexical categories (material, relational, mental, verbal, and behavioural). PWA and healthy controls produced a different distribution of lexical-semantic categories within the discourse sample. Armstrong found that PWA produced fewer mental and relational verbs, resulting in restricted communication. Verbs within the same category will often share similar semantic features; therefore, Armstrong's research demonstrates the need to examine discourse and, more importantly, examine feature access at the discourse level.

To this end, the purpose of the study, then, was to determine whether macro-level modality-specific features and certain categories (i.e., *living* and *non-living*) used in discourse by participants with anomic aphasia differed from those used by cognitively healthy participants. Antonucci (2014) and Warrington and McCarthy (1987) found that PWA had more trouble with sensory features compared with function features. Therefore, it was hypothesised that the discourse produced by participants with anomic aphasia would contain fewer references associated with sensory features. However, Antonucci (2014) did not find a categorical deficit, and Warrington and McCarthy (1987) only found a categorical deficit in a participant with severe global aphasia. Therefore, it was hypothesised that people with anomic aphasia would not produce concepts associated with *living* things or *non-living* things in a different distribution compared to healthy controls.

Method

Participants

Language samples from 19 participants with anomic aphasia (19 white) and 19 controls (18 white, 1 Hispanic/Latino) were retrieved from AphasiaBank (MacWhinney, Fromm, Forbes, & Holland, 2011), an online shared database that collects and analyses digital recording of discourse across a series of tasks. Paired-sample *t* tests were conducted for both age and education. The mean age of the participants was 62.74 (*SD* = 13.90) for PWA and 62.95 (*SD* = 14.25) for the controls; $t(18) = -.042$, $p = .967$. For education, PWA had 15.79 (*SD* = 2.92) years of education, and the control group had 16.21 (*SD* = 2.97) years of education; $t(18) = -.426$, $p = .675$.

All PWA met criteria for the study that included: (a) no reported history of psychiatric or neurodegenerative disorders, (b) aided or unaided hearing acuity, (c) corrected or uncorrected visual acuity, (d) English as their primary language, (e) chronic aphasia (at least 6 months post onset), (f) left hemisphere damage, and (g) a classification of anomic aphasia as determined by clinical interactions and the Boston classification system. The mean aphasia quotient (AQ) on the *Western Aphasia Battery-Revised* (WAB-R, Kertesz, 2007) was 88.83 (*SD* = 8.66).

The control group met criteria for the study that included (a) no history of stroke, head injury, or neurological condition; (b) aided or unaided hearing acuity; (c) corrected or uncorrected visual acuity; and (d) normal cognitive function as indicated by the *Mini Mental State Examination* (Folstein, Folstein, & McHugh, 2001). Demographic information is included in Table 1.

Discourse task

The discourse tasks included sequential pictures, single pictures, and a wordless picture book. The three tasks were collected in a single session, and all were video recorded. For this experiment, only participants' discourse sample for the wordless picture book, *Cinderella* (Grimes, 2005), was included. *Cinderella* is a book that illustrates the events from the classic Cinderella story. For the storytelling task, participants were presented with the book and allowed to look through it for as long as they wanted to remind themselves of the story. Then, the book was removed, and they were asked to tell the story in their own words. More information on AphasiaBank's research protocol can be found at: www.talkbank.org/AphasiaBank/protocol/. This storytelling was analysed because previous researchers have demonstrated that it provides a better sample of neurologically intact adults' vocabulary diversity; and, for PWA, it provides a similar sample of vocabulary diversity as sequential pictures (Fergadiotis & Wright, 2011).

Table 1. Means and (standard deviations) for group demographic information.

	Groups	
	Anomic aphasia (*N* = 19)	Healthy control (*N* = 19)
Age	62.74 (13.90)	62.95 (14.25)
Gender (male:female)	9:10	9:10
Years of education	15.79 (2.92)	16.21 (2.97)
Months post onset	52.21 (33.34)	N/A
WAB-R AQ	88.83 (8.66)	N/A
MMSE	N/A	56.68 (8.44)

Notes: WAB-R AQ, Western Aphasia Battery-Revised aphasia quotient; MMSE, Mini Mental Status Examination.

Transcription and language sample preparation

Samples were video recorded and orthographically transcribed into the CHAT format, which is compatible with a set of programs called Computerized Language Analysis (CLAN, MacWhinney, 2000). Samples were segmented into c-units. A c-unit is a communication unit that includes an independent clause with its modifiers (Loban, 1976). More information on the transcription procedures can be found in Appendix 1.

Semantic knowledge analysis development and training

Cree and McRae (2003) developed a macro-scale semantic knowledge coding system that was based on distinct brain regions hypothesised to process modality-specific knowledge. The semantic feature analysis is adapted from previous single-concept research into feature production (Cree & McRae, 2003). The researchers sought to explain category deficits through categorical feature make-up. Cree and McRae's (2003) coding system was intended for single lexical items. Yet the system can be adapted to discourse for two reasons: (a) participants typically provided phrase and sentences as a single feature; and (b) the semantic knowledge types developed by Cree and McRae are used in typical story telling. For example, the knowledge type *motion* indicates that some character or object is moving. To analyse discourse, the original nine knowledge types were used. However, discourse is more complex than single concepts, so another knowledge type that was originally postulated by Cree and McRae (2003) was added, *internal state*. Researchers have also found that *living thing* deficits are more common than *non-living* thing deficits (Moss & Tyler, 2000), so nouns were coded as either *living* or *non-living*.

The knowledge types included seven types that represented the senses: *colour, parts and surface properties, motion, smell, sound, tactile*, and *taste*. The other knowledge types involved non-sensory/functional knowledge. *Function* represents the functional and motion knowledge for how people use and interact with tools, objects, or other concepts. *Internal state* is the understanding that entities can have their own desires, goals, and emotions. *Encyclopaedic* knowledge is a wide-ranging category for any knowledge that does not fit into the previous knowledge types and is used when the participant provides information that is either based on facts, location, relationships, or time. For the category types, *living things* include animals, plants, or small groups that are made up of living creatures (e.g., family). *Non-living things* include abstract ideas, locations (e.g., meadow), or objects. Table 2 contains examples of words and the semantic knowledge type that the word belonged.

The coders followed a multistep training protocol prior to independently coding study participants' transcripts. The training protocol included three steps: (a) reviewing the definitions for each semantic knowledge and category type, (b) examining an already coded transcript, and (c) practice coding another coded transcript until agreement was >90%. The training protocol is available upon request.

Semantic knowledge analysis procedures

The transcripts were coded for semantic knowledge types with nouns also coded as either *living* or *non-living*. The transcripts were coded in CLAN by expanding the error tag system. For the coding system, only content words were coded. No functional words (e.g., modal, auxiliaries, prepositions, or pronouns) were coded, nor was the verb *to be*. For each c-unit within a transcript, the coder divided it into typical linguistic phrases (e.g.,

Table 2. Examples of semantic knowledge types and category types.

Semantic knowledge and category types	Words
Living things	Mom, sisters, prince, horses, girls, mice
Non-living things	Castle, house, ball, signs, trunk
Visual—colour	White, pink
Visual—parts and surface	Glass, big, young, small, little, foot, face
Visual—motion	Go, chasing, dancing, running, went
Smell	Smells
Sound	(Clock) strikes, laughing, listening, said
Tactile	Dress, put on, wear, have, hold
Taste	Food, cook, taste, pumpkin, eat
Function	Clean, scrub, pumpkin, wand, drive
Encyclopaedic	Castle, home, night, twelve o'clock, outside
Internal	Cruel, mean, thinking, sad

noun phrase, verb phrase, prepositional phrase, etc.). In these phrases, content words were judged to be together or separate based on the information they provided. Finally, the concepts within each phrase were coded into one of the 10 knowledge types, with nouns coded as either *living* or *non-living*. To do this, the word's meaning within the utterance was judged as belonging most closely to one of the 10 categories. For example, if the concept related to one of the seven sensory knowledge types (e.g., *eat*), the core feature that defined that concept was chosen and used to classify the concept into one of the 10 categories (e.g., <*eat*> *[* taste]*). The same was done for concepts that belonged to the non-sensory information. If the concept was acting as a place (e.g., castle), the concept was coded as encyclopaedic. If the concept dealt with specific tasks (e.g., cleaning or chores), the concepts were labelled as function. Appendix 2 contains more information about procedures used to code the discourse transcripts. After the transcripts were coded, CLAN was used to generate the number of semantic knowledge types used in each transcripts. These numbers were placed into a spreadsheet.

Reliability

All semantic knowledge types were used in the coding of the discourse transcripts. Eight transcripts were recoded by the same trained individual or another trained individual to check for intra- and inter-rater agreement. Reliability was measured by dividing each semantic knowledge and category type of the original coder by the new transcript. The formula was x_1/x_2, where x_1 is the initial frequency and x_2 is the new frequency. Finally, the ratios created by the semantic knowledge and category types were averaged together. Intra-rater agreement was 93.8%, and inter-rater agreement was 90.1%.

Results

The data represent the number of instances semantic knowledge types and category types were used within the discourse transcripts. All variables, semantic knowledge types and category types, were independent observations. The data were counts and positively skewed, as observed on histograms. Therefore, a Poisson distribution, which is positively skewed, was used to fit the data. Table 3 shows the mean counts and percentages for the semantic knowledge types and category types.

Table 3. Mean counts and percentages (standard deviations) for semantic knowledge and category types between groups.

	Healthy control		Anomic aphasia	
	Counts (*SD*)	Percentage	Count (*SD*)	Percentage (SD)
Parts and surface	21.21 (13.17)	11.16 (3.71)	7.74 (5.91)	10.27 (6.32)
Motion	16.47 (8.25)	11.16 (3.71)	7.11 (4.99)	10.27 (6.32)
Colour	.105 (.32)	0.17 (0.67)	.052 (.23)	0.05 (0.22)
Sound	7.68 (5.81)	3.96 (2.10)	1.74 (1.82)	2.92 (1.93)
Smell	.052 (.23)	0.01 (0.07)	0.00 (.000)	0.00 (0.00)
Tactile	7.63 (4.044)	4.46 (1.55)	2.58 (2.12)	4.22 (3.26)
Taste	1.63 (1.011)	0.96 (0.64)	.58 (.84)	0.79 (6.13)
Function	17.58 (7.805)	10.07 (2.84)	7.32 (6.14)	10.47 (5.64)
Encyclopaedic	75.63 (31.89)	44.44 (5.24)	28.79 (14.37)	47.11 (9.65)
Internal	27.26 (14.70)	14.99 (3.83)	8.37 (5.47)	14.75 (7.76)
Living	32.21 (18.25)	46.27 (7.03)	17.11 (11.88)	48.04 (9.58)
Non-living	37.84 (22.31)	53.73 (7.03)	18.58 (10.60)	51.96 (9.58)

Note: For percentages, the knowledge types were divided by total semantic knowledge types or category types.

A series of generalised linear models using the Poisson distribution as the baseline was used to analyse the data. The semantic knowledge and category types were the dependent variables with the factor being group. Because of the variability in length of the discourse samples, a log was taken of the number of words (tokens) produced for each transcript. The log(tokens) was used as an offset variable to control for the variability in discourse sample length. To correct for overdispersion, the scale parameter was set to a Pearson χ^2, which produces a more conservative standard error. The Poisson distribution requires the mean and variance to be equal, but some observations' variance can exceed the mean, which makes the observations overdispersed in respects to a Poisson distribution. Therefore, both a Poisson loglinear and negative binominal regression model were estimated. A negative binominal model has an extra parameter compared with the Poisson model which makes it more robust against differences in variances when compared to the mean. To compare the models, the log likelihood values were examined. A smaller log likelihood value for the negative binominal model indicates the model is not an improvement over the standard Poisson loglinear model.

To determine whether there is overdispersion in the standard Poisson model for semantic knowledge types, the likelihood ratios were compared for the standard Poisson model and a negative binominal regression model. The negative binominal models produced smaller likelihood ratios, indicating that the negative binominal model does not offer any improvement over the standard model.

To address the first aim of the study of whether semantic knowledge differed in the discourse samples between the two groups, a Poisson loglinear regression model was fit to each of the semantic knowledge types. The factor was group with an offset variable being the log of the number of tokens produced in each story. As shown in Table 4, only the Poisson models for *sound*, Wald $\chi^2 = 8.894$, $p = .003$, and *internal state*, Wald $\chi^2 = 6.597$, $p = .010$, were significantly different, with the healthy controls producing 1.835 times more *sound* features and 1.351 times more *internal state* features compared to the aphasia group. To examine the goodness of fit of the models, the deviance was divided by its degrees of freedom. Any number around 1 is considered a good fit. The Omnibus Test

Table 4. Poisson loglinear model results for semantic knowledge type.

	B	*SE*	Wald χ^2	*df*	*p*	Exp(*B*)
Sound (control)	.607	.2035	8.894	1	.003	1.835
Internal (control)	.301	.1171	6.597	1	.010	1.351

was also used to indicate whether the model was different from an intercept only model. For the *sound* features, the deviance was 53.908 with 36 degrees of freedom, which produced a goodness of fit value of 1.497. The Poisson model for *sound* features was significantly different than the intercept, $\chi^2(1) = 10.37$, $p = .002$. For the Poisson model with *internal* features, the deviance was 56.822 with 36 degrees of freedom, which produced a value of 1.578. The Poisson model for *internal* features was significantly different than the intercept, $\chi^2(1) = 6.942$, $p = .008$.

To address the second aim of the study of whether category types differed in the discourse samples between the two groups, a Poisson loglinear model and negative binominal model were estimated. The negative binominal model produced a larger likelihood ratio, which suggests the model fit the data better than the Poisson model. No significant differences were found between the groups for category types.

Discussion

The purpose of this study was to determine how semantic knowledge and category types are used in discourse produced by participants with anomic aphasia and cognitively healthy controls. The differences between the knowledge types, *sound* and *internal state*, were significant between the groups. For category types, there were no significant differences between the groups. While healthy controls produced significantly more items associated with the knowledge types, *sound* and *internal state*, the groups produced discourse with a similar proportion of semantic knowledge and category types (see Table 3). Therefore, the results of the study were mixed. Since PWA and healthy controls had similar proportions of semantic knowledge types, it is suggested that the participants understood what semantic knowledge and category types were necessary to tell the story, even if they could not produce items associated with *sound* and *internal states* as reliably as healthy adults.

PWA produced significantly fewer items associated with the semantic knowledge types, *sound* and *internal state*. The difference found in the semantic knowledge types might be related to the distinctiveness or abstractness of these knowledge types. For example, Mason-Baughman and Wallace (2014) found that PWA had difficulty processing distinctive features with low importance for concept verification. This agrees with other research on distinctive features (Antonucci, 2014). *Sound* features are often categorised as being distinct to the entity emitting the sound, but during normal circumstances, *sound* features serve little purpose in distinguishing concepts. A cow is the only animal that goes *moo*, but people can identify cows without hearing their distinctive call. If the sound elements for this particular story were of low importance, PWA might have trouble producing *sound* features in an online discourse production. As shown in Table 2, the *sound* features produced were strike and laughing, which can be considered a distinct feature of low importance for clocks and people.

Armstrong (2001) also found that PWA produced fewer mental verbs. *Internal state* and mental are both characterised as semantic knowledge about feeling, thinking, and perceiving. The current study and Armstrong (2001) have demonstrated that PWA have difficulty accessing lexical items associated with the internal states of an individual. For discourse, this makes it difficult for PWA to ascribe feelings and motivations to the characters in the story. Armstrong claims that the inability to use mental verbs would make certain types of discourse, such as discourse of argument, difficult for PWA. If this deficit extends beyond verbs and to all words denoting the *internal state* or mental status of characters, communicating the beliefs and internal motivations of characters would be difficult for PWA. Unfortunately, many discourse types require goal-directed behaviour as a key component to its story grammar (Coelho, 2002).

Researchers have found superordinate concepts deficits in PWA because superordinate concepts are usually more abstract than basic-level concepts (Marques et al., 2013). For example, it is easy to picture a *dog* or *cat*, but it is rather hard to picture an *animal* without relying on a more basic-level concept, such as *dog* or *cat*. Roll et al. (2012) also found that participants with Broca's aphasia produced more concrete words and less abstract words in a free recall. The researchers had 3 PWA and 12 controls that were matched for education. The participants were presented with 60 words (30 abstract and 30 concrete) and asked to say the first words that came to mind. The results agree with Kiran, Sandberg, and Abbott (2009), who found participants with anomic aphasia treated on harder abstract concepts generalised better than participants trained on concrete concepts. The participants in the current study might have produced fewer lexical items associated with *internal state* because the concepts are more abstract. For example, the word *think* does not have many sensory features associated with it. The word also does not possess many functional features. It is much more difficult for a person to describe how to *think* than to describe how to use a hammer or paint a wall. If the differences in items produced associated with *internal state* are because of these items' abstract nature, any abstract features might be difficult to produce within discourse. Future studies will be needed to determine whether the differences found arose simply because the knowledge type, *internal states*, is more abstract than the other types of features used in the study.

The results differ from single-concept research where researchers focused on sensory/functional features for living and non-living concepts (Antonucci, 2014; Warrington & McCarthy, 1987) or distinctive versus common features (Mason-Baughman & Wallace, 2014). Unlike Warrington and McCarthy (1987), the current study did not find any differences in category type between the participants with anomic aphasia and healthy controls. Warrington and McCarthy (1987) concluded that categorical deficits arise from differential loss of semantic knowledge types. The researchers most likely found categorical deficits because their participant had a large lesion and global aphasia. The large lesion probably damaged not only the transmission of semantic information, but there was probably some damage to part of the semantic system itself. The current study only included participants with anomic aphasia. Participants with anomic aphasia typically present with word-finding difficulties, but the rest of the language system is relatively preserved. Therefore, while the participants had differential access to certain features types, the access difficulty did not rise to the level of categorical deficit.

However, the preserved proportion of knowledge types between PWA and healthy controls suggests that PWA know what macro-level information they need to include within the story. The results could be interpreted through Dell et al.'s (1997) interactive two-step model of lexical access. The interactive two-step model is a spreading activation model of lexical access that contains three representational layers: semantic, lemma, and phonological layer, with bidirectional connections between the semantic layer and lemma layer and also the lemma layer and phonological layer. The model is interactive, and therefore, the activation of a lemma form, such as *cat*, would produce activation of its phonological neighbours, *mat, sat*, and *hat*. In addition to this, the lemma form will activate the semantic nodes of any concept related to *cat*, such as *dogs* or *tigers*. According to Dell et al., PWA produce lexical errors because of diminished activation transmission between the layers. With reduced activation transmitted between the layers, the model becomes less accurate.

While the model is meant for accessing single concepts, it could explain the significantly fewer items produced within the discourse sample pertaining to the knowledge *type internal state*. As discussed earlier, *internal state* contains lexical items more abstract than many of the semantic knowledge types. Abstract items usually have a smaller semantic network. Therefore, the transmission deficit is harder to overcome for abstract concepts compared with concrete concepts. Yet the participants can still access the semantic representation. Therefore, they would understand what semantic knowledge is required to tell the story and possibly try to produce this knowledge. This effort might be reflected in the similar distribution of semantic knowledge and category types produced between the participants. However, how this will react during discourse, which provides richer semantic environment with more noise than single-concept access, is unknown. PWA do appear to produce more errors during discourse production than simple naming task (Marini, Andreetta, Del Tin, & Carlomagno, 2011), so the extra information within discourse probably does not facilitate word access, especially for abstract concepts.

Limitations

Future studies should consider a more holistic discourse analysis approach as it may shed light on how PWA and healthy controls are using and constructing the semantic knowledge types presented here. Moreover, a more fine-grained semantic analysis system could highlight PWA strengths and weakness better than the large-scale features used within this study. For example, Armstrong (2001) found differences in relational verbs between PWA and healthy controls. The current study collapsed relational knowledge, along with time and location, into the encyclopaedic category. More fine-grain categories might reveal more specific semantic impairments. Finally, the current study limited its investigation to people with anomic aphasia. More severe forms of aphasia, such as global, might present with enough impairment to present with categorical deficits as shown by Warrington and McCarthy (1987). Moreover, since *internal states* knowledge is associated with the temporal-parietal junction (Saxe & Kanwisher, 2003), non-fluent aphasias, such as Broca's, might present with preserved access to items associated with internal states. Therefore, future research should examine semantic knowledge within discourse in different types and severities of aphasia and consider lesion location as well.

Conclusion

The results indicate there was a small difference between participants with anomic aphasia and healthy controls in producing semantic knowledge types. This study extends semantic feature analysis from the realm of single concepts into discourse, and we demonstrate that semantic feature analysis within discourse might provide useful information about the semantic abilities of PWA beyond single-concept research.

Acknowledgements

We are especially grateful to the study participants. We also thank Valentyna Hibbs and Amy Henderson in the Aging and Adult Language Lab at East Carolina University for assistance with language analyses. We are thankful to the Biostatistics Department at ECU and Dr Suzanne Hudson for helping us with the data analyses. We also thank AphasiaBank (http://www.talkbank.org/AphasiaBank/) for providing the data and transcripts that were used.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

This research was partially supported by the National Institute on Aging [grant number R01AG029476].

References

Antonucci, S. M. (2014). What matters in semantic feature processing for persons with stroke-aphasia: Evidence from an auditory concept–feature verification task. *Aphasiology*, *28*, 823–839. doi:10.1080/02687038.2014.913769

Armstrong, E. (2001). Connecting lexical patterns of verb usage with discourse meanings in aphasia. *Aphasiology, 15*(10–11), 1029–1045. doi:10.1080/02687040143000375

Ash, S., Moore, P., Vesely, L., Gunawardena, D., McMillan, C. T., Anderson, C., . . . Grossman, M. (2009). Non-fluent speech in frontotemporal lobar degeneration. *Journal of Neurolinguistics*, *22*, 370–383. doi:10.1016/j.jneuroling.2008.12.001

Boyle, M. (2004). Semantic feature analysis treatment for anomia in two fluent aphasia syndromes. *American Journal of Speech-Language Pathology*, *13*, 236–249. doi:10.1044/1058-0360(2004/025)

Coelho, C. A. (2002). Story narratives of adults with closed head injury and non-brain injured adults: Influence of socioeconomic status, elicitation task, and executive functioning. *Journal of Speech, Language, and Hearing Research*, *45*, 1232–1248. doi:10.1044/1092-4388(2002/099)

Cree, G. S., & McRae, K. (2003). Analyzing the factors underlying the structure and computation of the meaning of chipmunk, cherry, chisel, cheese, and cello (and many other such concrete nouns). *Journal of Experimental Psychology: General*, *132*, 163–201. doi:10.1037/0096-3445.132.2.163

Dell, G. S., Schwartz, M. F., Martin, N., Saffran, E. M., & Gagnon, D. A. (1997). Lexical access in aphasic and nonaphasic speakers. *Psychological Review*, *104*, 801–838. doi:10.1037/0033-295X.104.4.801

Fergadiotis, G., & Wright, H. H. (2011). Lexical diversity for adults with and without aphasia across discourse elicitation tasks. *Aphasiology*, *25*, 1414–1430. doi:10.1080/02687038.2011.603898

Folstein, M. F., Folstein, S. E., & McHugh, P. R. (2001). *Mini mental state examination*. Lutz, FL: Psychological Assessment Resources, Inc.

Goodglass, H., & Wingfield, A. (1997). *Anomia: Neuroanatomical and cognitive correlates*. San Diego, CA: Academic Press.

Grimes, N. (2005). *Walt Disney's Cinderella*. New York, NY: Random House.

Haarbauer-Krupa, J., Moser, L., Smith, G., Sullivan, D. M., & Szekeres, S. F. (1985). Cognitive rehabilitation therapy: Middle stages of recovery. In M. Ylvisaker (Ed.), *Head injury rehabilitation: Children and adolescents* (pp. 287–310). San Diego, CA: College-Hill Press.

Howard, D., & Patterson, K. (1992). *Pyramids and palm trees: A test of semantic access from pictures and words*. London: Thames Valley Publishing.

Jefferies, E., & Lambon Ralph, M. A. (2006). Semantic impairment in stroke aphasia versus semantic dementia: A case-series comparison. *Brain*, *129*, 2132–2147. doi:10.1093/brain/awl153

Jefferies, E., Patterson, K., & Ralph, M. A. L. (2008). Deficits of knowledge versus executive control in semantic cognition: Insights from cued naming. *Neuropsychologia*, *46*, 649–658. doi:10.1016/j.neuropsychologia.2007.09.007

Jefferies, E., Rogers, T. T., Hopper, S., & Lambon Ralph, M. A. (2010). 'Pre-semantic' cognition revisited: Critical differences between semantic aphasia and semantic dementia. *Neuropsychologia*, *48*, 248–261. doi:10.1016/j.neuropsychologia.2009.09.011

Kaplan, E., Goodglass, H., & Weintraub, S. (2001). *Boston naming test* (2nd ed.). Austin, TX: Pro-Ed.

Kertesz, A. (2007). *Western aphasia battery – revised*. New York, NY: Grune & Stratton.

Kintsch, W. (1994). The psychology of discourse processing. In M. A. Gernsbacher (Ed.), *Handbook of psycholinguistics* (pp. 721–739). San Diego, CA: Academic Press.

Kiran, S., Sandberg, C., & Abbott, K. (2009). Treatment for lexical retrieval using abstract and concrete words in persons with aphasia: Effect of complexity. *Aphasiology*, *23*, 835–853. doi:10.1080/02687030802588866

Lambon Ralph, M. A. (2014). Neurocognitive insights on conceptual knowledge and its breakdown. *Philosophical Transactions of the Royal Society B, 369*, 20120392. doi:10.1098/rstb.2012.0392

Loban, W. (1976). *Language development: Kindergarten through grade twelve*. Urbana, IL: National Council of Teachers of English.

MacWhinney, B. (2000). *The CHILDES project: Tools for analyzing talk* (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum Associates.

MacWhinney, B., Fromm, D., Forbes, M., & Holland, A. (2011). AphasiaBank: Methods for studying discourse. *Aphasiology*, *25*, 1286–1307. doi:10.1080/02687038.2011.589893

Marini, A., Andreetta, S., Del Tin, S., & Carlomagno, S. (2011). A multi-level approach to the analysis of narrative language in aphasia. *Aphasiology*, *25*, 1372–1392. doi:10.1080/02687038.2011.584690

Marques, J. F., Mares, I., Martins, M. E., & Martins, I. P. (2013). The hierarchical organization of semantic knowledge in stroke aphasia: The role of feature sharedness and executive function. *Journal of Neurolinguistics*, *26*, 552–560. doi:10.1016/j.jneuroling.2013.03.005

Martin, A. (2001). Functional neuroimaging of semantic memory. In R. Cabeza & A. Kingstone (Eds.), *Handbook of functional neuroimaging of cognition* (pp. 153–186). Cambridge, MA: MIT Press.

Mason-Baughman, M. B., & Wallace, S. E. (2014). Role of importance and distinctiveness of semantic features in people with aphasia: A replication study. *Communication Disorders Quarterly*, *35*, 158–166. doi:10.1177/1525740113518342

Moss, H. E., & Tyler, L. K. (2000). A progressive category-specific semantic deficit for non-living things. *Neuropsychologia*, *38*, 60–82. doi:10.1016/S0028-3932(99)00044-5

Noonan, K. A., Garrard, P., Jefferies, E., Eshan, S., & Lampon Ralph, M. A. (2013). Demonstrating the qualitative differences between semantic aphasia and semantic dementia: A novel exploration of nonverbal semantic processing. *Behavioural Neurology*, *26*, 7–20. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=psyh&AN=2012-35210-002&site=ehost-live

Noonan, K. A., Jefferies, E., Corbett, F., & Lambon Ralph, M. A. (2009). Elucidating the nature of deregulated semantic cognition in semantic aphasia: Evidence for the roles of prefrontal and temporo-parietal cortices. *Journal of Cognitive Neuroscience*, *22*, 1597–1613.

Peach, R. K., & Reuter, K. A. (2010). A discourse-based approach to semantic feature analysis for the treatment of aphasic word retrieval failures. *Aphasiology*, *24*, 971–990. doi:10.1080/02687030903058629

Rider, J. D., Wright, H. H., Marshall, R. C., & Page, J. L. (2008). Using semantic feature analysis to improve contextual discourse in adults with aphasia. *American Journal of Speech-Language Pathology*, *17*, 161–172. doi:10.1044/1058-0360(2008/016)

Roll, M., Mårtensson, F., Sikström, S., Apt, P., Arnling-Bååth, R., & Horne, M. (2012). Atypical associations to abstract words in Broca's aphasia. *Cortex*, *48*, 1068–1072. doi:10.1016/j.cortex.2011.11.009

Saxe, R., & Kanwisher, N. (2003). People thinking about people: The role of the temporo-parietal junction in "theory of mind". *NeuroImage, 19*, 1835–1842. doi:10.1016/S1053-8119(03)00230-1

Schwartz, M. F., Dell, G. S., Martin, N., Gahl, S., & Sobel, P. (2006). A case-series test of the interactive two-step model of lexical access: Evidence from picture naming. *Journal of Memory and Language*, *54*, 228–264. doi:10.1016/j.jml.2005.10.001

Thompson, H. E., & Jefferies, E. (2013). Semantic control and modality: An input processing deficit in aphasia leading to deregulated semantic cognition in a single modality. *Neuropsychologia*, *51*, 1998–2015. doi:10.1016/j.neuropsychologia.2013.06.030

Warrington, E. K., & McCarthy, R. A. (1987). Categories of knowledge: Further fractionations and an attempted integration. *Brain*, *110*, 1273–1296. doi:10.1093/brain/110.5.1273

Wright, H. H., & Capilouto, G. J. (2009). Manipulating task instructions to change narrative discourse performance. *Aphasiology*, *23*, 1295–1308. doi:10.1080/02687030902826844

Appendix 1

The following is an example of a c-unit as appears in Wright and Capilouto (2009):

Pre-c-unit segmented sample:

There's a family of mice that live in a house in the forest and one day they decide to pack everyone up a large family of mice into the truck and go out for a picnic the whole family.

C-unit segmented:

(1) There's a family of mice that live in a house in the forest.
(2) And one day they decide to pack everyone up a large family of mice into the truck and go out for a picnic the whole family.

Appendix 2

The discourse transcripts were coded in the following manner: (1a) divide c-unit into linguistic phrases; (1b) remove function words; (1c) group content words into concepts that correspond to the 10 semantic knowledge types; and (1d) code the knowledge types. What follows is an example of these steps applied to a PWA's c-unit:

(1) Twin sisters are very cruel and forced her to clean the house.
 (1a) Twin sisters / are / very cruel / and forced / her / to clean / the house.
 (1b) Twin sisters / ~~are~~ / ~~very~~ cruel / ~~and~~ forced / ~~her~~ / ~~to~~ clean / ~~the~~ house.
 (1c) <Twin> <sisters> / ~~are~~ / ~~very~~ <cruel> / ~~and~~ <forced> / ~~her~~ / ~~to~~ <clean> / ~~the~~ <house>.
 (1c) <Twin>[* parts and surface] <sisters>[* living][*encyclopedic] / ~~are~~ / ~~very~~ <cruel>[* internal] / ~~and~~<forced>[* encyclopedic] / ~~her~~ / ~~to~~ <clean>[* function] / ~~the~~ <house>[* encyclopedic].