Selectivity of lexical-semantic disorders in Polish-speaking patients with aphasia: Evidence from single-word comprehension

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Abstract

Several neuropsychological studies have shown that patients with brain damage may demonstrate selective category-specific deficits of auditory comprehension. The present paper reports on an investigation of aphasic patients’ preserved ability to perform a semantic task on spoken words despite severe impairment in auditory comprehension, as shown by failure in matching spoken words to pictured objects. Twenty-six aphasic patients (11 women and 15 men) with impaired speech comprehension due to a left-hemisphere ischaemic stroke were examined; all were right-handed and native speakers of Polish. Six narrowly defined semantic categories for which dissociations have been reported are colors, body parts, animals, food, objects (mostly tools), and means of transportation. An analysis using one-way ANOVA with repeated measures in conjunction with the Lambda-Wilks Test revealed significant discrepancies among these categories in aphasic patients, who had much more difficulty comprehending names of colors than they did comprehending names of other objects ($F_{(5,21)} = 13.15$; $p < .001$). Animals were most often the easiest category to understand. The possibility of a simple explanation in terms of word frequency and/or visual complexity was ruled out. Evidence from the present study support the position that so called “global” aphasia is an imprecise term and should be redefined. These results are discussed within the connectionist and modular perspectives on category-specific deficits in aphasia.

Keywords: Selective category-specific deficits; Auditory comprehension; Aphasia

1. Introduction

Aphasia is a family of clinically diverse disorders following brain damage that affect various levels of symbolic language processing. It combines a multiplicity of deficits that manifest in one or more aspects of language use (Goodglass, 1993; Jodzio, 2005). It has been shown that patients with aphasia often experience more problems comprehending some categories of words than others. In unique cases, the deficit may be limited to individual semantic categories (e.g., fruits or vegetables), whereas their comprehension of other semantic categories may be relatively intact (Kertesz, Davidson, & McCabe, 1998; Semenza, 2006). In order to assess the auditory perception of a single-word, a patient is usually asked to point to a picture corresponding with a word spoken aloud by the examiner (the word-picture matching task). Although it is possible that impaired performance on this task may not only be due to semantic deficits, but also...
caused by phonetic and/or visual problems (Rapp & Caramazza, 1998), is it generally accepted that performance on this type of task is significantly related to the concreteness of the word. This was first described in 1946 by Nielsen (for review see Warrington & Shallice, 1984) and later replicated by Goodglass, Klein, Carey, and Jones (1966) who noted that in a large but heterogeneous group of aphasics patients, objects were a significantly more difficult category to name than other categories such as body parts, actions, colors, numbers, and letters. In auditory comprehension this relationship was, however, reversed.

The notion of a selective impairment of semantic knowledge was further investigated by Warrington and coworkers (Crutch & Warrington, 2003; Warrington & Shallice, 1984; see also Semenza & Bisiacchi, 1999). These authors examined single-word processing in four patients with herpes simplex encephalitis. Interestingly, one of the patients demonstrated a significant impairment in naming and/or visual recognition of living things (i.e., animals) and biological categories (i.e., fruit, or vegetables), whereas this patient’s ability to identify inanimate things and man-made categories (i.e., tools, vehicles) was relatively intact. These findings have inspired and developed further studies (for review see Arguin, 2002; Farah & Grossman, 1997) that provided converging evidence of category-specific deficits not only in patients with brain infections (Pietrini et al., 1988) but also in patients with neurodegenerative diseases (Coslett, Saffran, & Schwoebel, 2002; Daniele, Silveri, Giustolisi, & Gainotti, 1993; Laws, Gale, Leeson, & Crawford, 2005; Montanes, Goldblum, & Boller, 1995), traumatic brain injuries (Goodglass & Wingfield, 1993), as well as from a variety of vascular conditions (Deloche, Andreewsky, & Desi, 1981; Gold & Kertesz, 2000). Moreover, recent studies using a conceptual priming paradigm in healthy individuals have provided additional support for the fact that human semantic memory may be organized around a living/non-living dichotomy (Gold, Beauregard, Lecours, & Chertkow, 2003).

Recently, several reports of patients with selective impairment in naming and/or comprehension have demonstrated that the category-specific deficits may differ not only in terms of a semantic domain but also in the level of generality (superiority) of concepts. For example, damage to the hemisphere dominant for language (usually left) may selectively affect the concept processing, including verbs (or nouns), living things (or inanimate objects), proper names (first and last names of famous people or friends), food (like fruit and vegetables), plants, animals, geographical terms, colors, body parts and other items (Forde & Humphreys, 2002). Additionally, since symptoms sometimes are confined only to difficulties with naming, leaving the auditory comprehension intact, some researchers have suggested an existence of at least two specific semantic systems in the human mind: a category-specific meaning system (also known as domain-specific knowledge) and a modality-specific meaning system (Caramazza & Shelton, 1998; McCarthy & Warrington, 1990). This hypothesis is partially consistent with the Allport’s theory (1985, according to Shallice, 1998, p. 303) suggesting that the semantic memory consists of different sensorimotor representations (i.e., knowledge derived from a visual channel, knowledge based on tactile sensations, or knowledge acquired during a motor activity), which are associated with systems outside the semantic memory. This idea was also supported by previously cited Warrington and Shallice (1984) investigating the nature of semantic disorders in patients with neurological conditions.

However, the hypothesis of a highly specialized, modular organization of semantic knowledge has been widely criticized by investigators who favor a homogeneous but internally strongly interactive architecture of semantic memory. It has been postulated that the impression of the selectivity of the lexical-semantic symptoms is very often illusory, especially when the interaction of some additional variables is controlled (i.e., the degree of complexity of the visual stimulus used in a study together with a frequency of a given word in a particular language – Gold et al., 2003; Montanes et al., 1995; Nicholas & Sinotte, 2003). Despite this criticism, there is agreement that detailed analysis of selectively impaired processes of verbal comprehension in aphasia is important not only from a clinical and practical point of view but also from a cognitive and theoretical perspective. The aphasiological studies reported above may be additionally perceived as a part of a more general discussion on the selective information processing (i.e., in memory area – for comments see Hankala, 2001). Moreover, it was the development of the models of semantic memory during 1970s that encouraged aphasiologists to include the detailed linguistic characteristics of communication difficulties in the diagnostic process.

It is also worth noting that rapid development and refinement in neuroimaging technology, especially methods of functional brain imaging used among both healthy individuals and brain-damaged subjects, has recently shed additional light on the neural mechanisms of conceptual processes involved in perception and its anatomical basis (see Price & Friston, 2002). For example, a picture matching positron emission tomography (PET) studies (Gold et al., 2003; Perani et al., 1995) found that the recognition of animals was strongly associated with bilateral activation of the inferior temporal cortex, whereas the presentation of non-living objects differentially activated the dorsolateral frontal
cortex. Furthermore, studies of patients with herpes simplex encephalitis have suggested that representations of living things are localized in the temporal lobes (Pietrini et al., 1988). Interestingly, research on naming and comprehending grammatically different words has also shown distinct involvement of particular lobes in lexical processes: the processing of verbs strongly relies on frontal lobes, while the identification of nouns seems to particularly activate temporal regions (Daniele et al., 1993).

The purpose of the present study was to characterize an impairment of the single-word auditory comprehension. Specifically, an attempt was made to identify the inter-individual as well as within-subject variability in processing of specific semantic categories among subjects with defective verbal comprehension due to the left-hemisphere stroke. Additionally, we analyzed the relationship between the presence of lexical-semantic deficits (an inability to understand single-words) and potential co-factors, including the severity of aphasia, time from the onset, sex, age, education as well as word frequency and visual complexity of pictures used in the examination.

2. Methods

2.1. Participants

Twenty-six aphasic patients (11 women and 15 men) with impaired speech comprehension due to a left-hemisphere (LH) ischaemic stroke were examined for the purpose of this study. The patients were between the ages of 35 and 73 years, with a mean of 60 years (S.D. = 10), and had an average of 10 years of education (S.D. = 3); all were right-handed and native speakers of Polish.

Aphasia resulted from a single cerebral infarction within the territory of the middle cerebral artery of the LH as determined by a clinical neurologist and computed tomography (CT) and/or MRI. Patients met the following selection criteria: (1) left-hemisphere stroke; (2) severe comprehension impairment, as clinically determined by a neurologist and a neuropsychologist; (3) no history of cerebral disease or disorder prior to the current stroke; (4) no signs of achromatopsia; (5) hearing adequate for completion of language tasks; and (6) more than 10 days post-onset at the time of inclusion in the study (in days, M = 132, S.D. = 137, range 10–461). In addition, patients had no known history of other significant medical disease such as psychiatric disorder, progressive dementia, substance abuse, or additional neurological events (e.g., head injury). Fulfillment of these criteria was determined by interviewing the patient’s relatives, and by reviewing the patient’s medical record. The same routinely applied pharmacological treatment (piretacem) was administered to the patients after suffering from their stroke. All individuals were recruited from the Department of Neurology at the Medical University of Gda´nsk in Poland between September 2001 and January 2004.

The study was approved by the local ethics committee affiliated with Medical University of Gda´nsk. Before testing, informed consent was obtained from each participant in the study. Each person was tested individually in a quiet testing room.

All patients presented with marked deficits of verbal comprehension. Seven subjects met criteria for Wernicke’s aphasia, four had transcortical sensory aphasia, and the remaining 15 patients had global aphasia. Categorization and evaluation of severity of aphasia was based on specific criteria and performance on the Boston Diagnostic Aphasia Examination (BDAE, Goodglass & Kaplan, 1983). Its Polish version, which takes into consideration social, cultural and linguistic aspects of testing, was developed by Ulatowska and Kadzielawa (Kadzielawa, 1990; see also Jodzio, Drumm, Nyka, Lass, & G˛asecki, 2005). According to BDAE screening criteria of language capacities, 6 subjects had moderate impairment, whereas 20 patients presented with severe comprehension deficits. A striking observation in most of our patients was a common infarction in both cortical and subcortical areas.

2.2. Materials

The ability of aphasic patients to comprehend single-words was assessed using six semantic categories. The order of difficulty of objects names (mostly tools), body parts, animals, food, colors, and means of transportation (12 words for each category) was determined by a task in which the patient was asked to choose the correct visual stimulus in response to the spoken name. An appropriate value, derived from the Polish Dictionary of Word Frequency (PDW) (Kurcz, Lewicki, Sambor, Szafran, & Woronczak, 1990), was assigned to each word. Values of word (name) frequency (Fr) derived from PDW, together with a mean and standard deviation calculated separately for each semantic category (list of words), are shown in Table 1. One-way analysis of variance (ANOVA) in conjunction with Duncan’s post hoc
Table 1

List of the stimuli in auditory comprehension task and their normative values WF, word frequency

<table>
<thead>
<tr>
<th>Objects</th>
<th>WF</th>
<th>Body parts</th>
<th>WF</th>
<th>Animals</th>
<th>WF</th>
<th>Food</th>
<th>WF</th>
<th>Colors</th>
<th>WF</th>
<th>Means of transport</th>
<th>WF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Telephone</td>
<td>56</td>
<td>Eye</td>
<td>295</td>
<td>Elephant</td>
<td>5</td>
<td>Grapes</td>
<td>-</td>
<td>Green</td>
<td>39</td>
<td>Bus</td>
<td>51</td>
</tr>
<tr>
<td>Axe</td>
<td>12</td>
<td>Hand</td>
<td>344</td>
<td>Fox</td>
<td>11</td>
<td>Carrot</td>
<td>6</td>
<td>Violet</td>
<td>-</td>
<td>Airplane</td>
<td>183</td>
</tr>
<tr>
<td>Frying-pan</td>
<td>-</td>
<td>Thumb (1)</td>
<td>-</td>
<td>Snail</td>
<td>-</td>
<td>Cake</td>
<td>-</td>
<td>Black</td>
<td>93</td>
<td>Roller-skate</td>
<td>-</td>
</tr>
<tr>
<td>Scissors</td>
<td>-</td>
<td>Leg</td>
<td>126</td>
<td>Cow</td>
<td>50</td>
<td>Red pepper</td>
<td>-</td>
<td>Orange</td>
<td>-</td>
<td>Sledge</td>
<td>-</td>
</tr>
<tr>
<td>Hammer</td>
<td>8</td>
<td>Foot</td>
<td>46</td>
<td>Rabbit</td>
<td>-</td>
<td>Sandwich</td>
<td>6</td>
<td>Yellow</td>
<td>19</td>
<td>Train</td>
<td>53</td>
</tr>
<tr>
<td>Padlock</td>
<td>4</td>
<td>Ear</td>
<td>54</td>
<td>Lion</td>
<td>12</td>
<td>Pineapple</td>
<td>-</td>
<td>Navy-blue</td>
<td>7</td>
<td>Car</td>
<td>143</td>
</tr>
<tr>
<td>Pipe</td>
<td>-</td>
<td>Palm</td>
<td>56</td>
<td>Cook</td>
<td>4</td>
<td>Bread</td>
<td>36</td>
<td>Red</td>
<td>52</td>
<td>Bicycle</td>
<td>12</td>
</tr>
<tr>
<td>Key</td>
<td>33</td>
<td>Nose</td>
<td>54</td>
<td>Turtle</td>
<td>4</td>
<td>Apple</td>
<td>11</td>
<td>Grey</td>
<td>29</td>
<td>Lorry</td>
<td>6</td>
</tr>
<tr>
<td>Iron</td>
<td>-</td>
<td>Mouth</td>
<td>70</td>
<td>Mouse</td>
<td>8</td>
<td>Onion</td>
<td>6</td>
<td>Pink</td>
<td>8</td>
<td>Sailing boat</td>
<td>-</td>
</tr>
<tr>
<td>Pencil</td>
<td>9</td>
<td>Forefinger</td>
<td>66</td>
<td>Duck</td>
<td>10</td>
<td>Mushroom</td>
<td>10</td>
<td>White</td>
<td>87</td>
<td>Motorcycle</td>
<td>10</td>
</tr>
<tr>
<td>Fork</td>
<td>-</td>
<td>Thumb (2)</td>
<td>-</td>
<td>Dog</td>
<td>62</td>
<td>Banana</td>
<td>-</td>
<td>Brown</td>
<td>12</td>
<td>Helicopter</td>
<td>11</td>
</tr>
<tr>
<td>Brush</td>
<td>5</td>
<td>Hair</td>
<td>39</td>
<td>Fish</td>
<td>60</td>
<td>Pear</td>
<td>6</td>
<td>Blue</td>
<td>24</td>
<td>Trolley</td>
<td>17</td>
</tr>
</tbody>
</table>

M 18.14a* 115.00b 22.60a 11.57a 37.00a 54.00a
S.D. 19.37 110.98 24.32 10.98 31.25 64.99

* Means marked ‘a’ subscript do not differ significantly at p<0.05.

test revealed significant differences between means defining the Fr in semantic categories (\(F_{(5,47)} = 3.96; p < .01\)). Only the frequency of names for body parts was statistically higher than the frequency of other categories, which did not differ from each others. According to criteria and results of ratings published by Snodgrass and Vanderwart (1980), the five sets (colors were excluded) were not matched for degree of visual complexity (\(F_{(4,55)} = 14.97; p < .001\)). Pictures of animals and means of transportation were more complex (mean values for ratings of complexity = 3.70 and 3.75, respectively) than the pictures of other categories (mean values: 2.48 for objects, 2.41 for body parts, 2.61 for food), which did not differ from each others.

Both the testing procedure and the scoring system used in the present study was based on BDAE criteria (Goodglass & Kaplan, 1983). We used a multiple-choice, auditory word-recognition (discrimination) task. Patients were audiotaly presented with a name of a word and then asked to point to a printed image depicting that word. Images (line drawn stimuli) of 72 words were printed on nine (21 cm × 27 cm) cards, so that each of those cards contained 8 different pictures (2 pictures chosen from 4 semantic categories). During the assessment, patients were provided with 1 out of 9 cards at a time and the same stimulus question (“Show me......”) was given 8 times (for 8 different words) at each card. The examiner asked the test-stimuli (names of pictures) in a random order, alternating between the semantic categories of names. The stimuli were adapted from the Snodgrass and Vanderwart (1980) picture set, typically used in category effect studies (Laws et al., 2005). If a patient was not able to identify the correct picture within the time limit of 5 s, the examiner repeated the name of the word once again. No additional help was provided. Scoring allowed full credit of two points for correct identification within 5 s, partial credit of one point for correct identification after more than 5 s (self-correction was permitted). Maximum (total) score possible was 144 points (24 points for each category containing 12 words).

Apart from the total score as well as the sub-scores for each semantic category, an index of the individual semantic disharmony (ISD) (a dissociation between the comprehension of different lexical-semantic categories) was created separately for each patient. As mentioned earlier, a patient’s ability to correctly identify the auditorily presented words from different categories varies and strongly depends on the semantic characteristic of the stimuli. Therefore, ISD indicates the spectrum of within-patient variability in word discrimination task. In a psychometric sense, ISD can be referred to as the discrepancy (absolute sub-score differences) between sub-scores obtained by a single participant (not by the entire group) in each of the 6 semantic categories. In order to create the ISD, standardized scores (z-scores) for each patient were calculated separately using the overall correct and the sub-scores from each semantic category (mean and S.D. values). However, since their sum equals zero, further analyses were conducted using absolute values only. Thus, ISD is a summed value of absolute z-scores; the higher ISD value, the greater the difference (dissociation) in the ability to comprehend lexical-semantic categories.

For example, patient B.W. with a global aphasia due to an extensive stroke of the left-hemisphere obtained on each category the following raw sub-scores: objects – 15 [3.5], body parts – 9 [−.62], animals – 21 [1.31], food – 16 [5.1], colors – 3 [−1.58], means of transport – 13 [.02]. The numbers in square brackets are the z-scores calculated based on
Table 2

Results of three patients with the mildest (patient JK), moderate (patient BW), and the most severe (patient WM) impairments in auditory comprehension of selective lexical-semantic categories

<table>
<thead>
<tr>
<th>Patient</th>
<th>Score</th>
<th>Objects</th>
<th>Body parts</th>
<th>Animals</th>
<th>Food</th>
<th>Colors</th>
<th>Means of transport</th>
<th>Indexes</th>
</tr>
</thead>
<tbody>
<tr>
<td>JK</td>
<td>Raw score</td>
<td>22</td>
<td>21</td>
<td>23</td>
<td>23</td>
<td>16</td>
<td>21</td>
<td>Total – 126</td>
</tr>
<tr>
<td></td>
<td>z-Score</td>
<td>-0.38</td>
<td>0.00</td>
<td>0.77</td>
<td>0.77</td>
<td>-1.92</td>
<td>0.00</td>
<td>ISD = 3.84</td>
</tr>
<tr>
<td>BW</td>
<td>Raw Score</td>
<td>15</td>
<td>9</td>
<td>21</td>
<td>16</td>
<td>3</td>
<td>13</td>
<td>Total – 77</td>
</tr>
<tr>
<td></td>
<td>z-score</td>
<td>0.35</td>
<td>-0.62</td>
<td>1.31</td>
<td>0.51</td>
<td>-1.58</td>
<td>0.02</td>
<td>ISD = 4.39</td>
</tr>
<tr>
<td>WM</td>
<td>Raw score</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>Total – 16</td>
</tr>
<tr>
<td></td>
<td>z-Score</td>
<td>-1.10</td>
<td>0.88</td>
<td>-1.10</td>
<td>0.88</td>
<td>-0.44</td>
<td>0.88</td>
<td>ISD = 5.28</td>
</tr>
</tbody>
</table>

ISD – index of disharmony in auditory comprehension of selective semantic categories; the higher ISD value, the greater the difference (dissociation) in the ability to comprehend lexical-semantic categories.

Table 3 contains raw sub-scores obtained by the whole group of subjects for different lexical categories. In order to compare mean values for each category, an analysis using one-way ANOVA with repeated measures was carried out (Ferguson & Takane, 1999). Using the Lambda-Wilks Test, we then examined within-group differences between categories. An analysis across categories at the group level revealed significant differences ($F(5,21) = 13.15; p < .001$). Effect size was satisfactory (partial eta squared = 0.758).

The most difficult category for the aphasia patients in our sample to comprehend was names of colors followed by names of body parts. Interestingly, the least difficult lexical-semantic category to comprehend in our study was the category of animals. Moreover, the number of properly identified words from this category did not differ from the number of correctly recognized names of objects and means of transportation.

We then examined the relationship between the prevalence of category-specific disorders (i.e., ISD – a within-patient dissociation between the comprehension of different lexical-semantic categories) and the variables that could hypothetically modify their nature: severity of aphasia, time from the onset, sex, age, education as well as word frequency (IWF). The only significant $r$-Pearson’s correlation was found between ISD and the total comprehension score ($r = -0.49; p < .01$). Its negative value suggests that the most selective (dissociable) deficits of single-word comprehension were typically seen in patients with more severe aphasia. This observation is additionally consistent with the scores shown in Table 2.

3. Results

The analysis revealed no “ceiling” or “floor” effect for the lexical task in any patient’s performance. In other words, the lowest total raw score (for a severely impaired patient) obtained for the recognition of words among aphasics was 16, whereas the maximal score was 126 (for a relatively mildly impaired patient; range: 0–144). This result indicates that the testing procedure had satisfactory psychometric properties (i.e., accurately adjusted level of difficulty). The patterns of performance of three patients with the lowest, the moderate and the highest total raw scores have been shown in Table 2.

Table 3 Mean values and S.D.s of auditory comprehension selective lexical-semantic categories in aphasic patients

<table>
<thead>
<tr>
<th>Colors</th>
<th>Body parts</th>
<th>Food</th>
<th>Objects</th>
<th>Means of transport</th>
<th>Animals</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>6.69a</td>
<td>10.31b</td>
<td>14.42c</td>
<td>15.04cd</td>
<td>15.04cd</td>
</tr>
<tr>
<td>S.D.</td>
<td>6.56</td>
<td>6.47</td>
<td>6.46</td>
<td>6.92</td>
<td>6.95</td>
</tr>
</tbody>
</table>

*a* Means sharing the same subscript (a–d) do not differ significantly at $p<0.05$. 
in the last column of Table 2. Other correlations did not reach statistical significance ($p > .18$). There were no gender differences correlating with the severity of ISD ($t = -90$, $df = 24$, $p = .38$).

4. Discussion

The present study revealed highly dissociable category-dependent disorders of single-word comprehension in patients with post-stroke aphasia. The pattern of within-patient deficits across semantic categories appears to be relatively consistent. The regularity of these disorders across the group might be a little surprising, since category-specific effects may be hidden within a group analysis because individual patients often manifest dissociations in opposing directions and so, cancel each other (for examples, see Laws et al., 2005). The aphasic patients in our study had much greater difficulty comprehending names of colors than they did comprehending other semantic categories. Animals were most often the easiest category to understand. Similar results have been obtained by Goodglass et al. (1966) as well as by Szumskas (1973; according to Kadzielawa, 1983), who examined semantic processing deficits in patients undergoing neurosurgical treatment of brain tumors.

The large discrepancies among categories imply that the lexical-semantic processes involved in comprehension of spoken single-words are differentially susceptible to disruption after brain damage. On the one hand, the results of the present study support the hypothesis that the auditory (language) processing is modular in nature (Polster & Rose, 1998). Worth noting, also the recognition of non-verbal stimuli (i.e., sounds from the environment, prosody) may become selectively impaired in patients sustaining brain damage. However, these deficits, if present, are usually observed in subjects with right hemisphere lesions (Harciarek, Heilman, & Jodzio, 2006; Polster & Rose, 1998; Ross, 1981). Thus, the inability to comprehend a particular category of information (i.e., names of body parts) would be then caused by a damage to the highly specialized module of cognitive processing. On the other hand, selective deficits observed in our patients may be due to some defective processes, like a deficit in accessing lexical-semantic knowledge (representations), and not necessarily caused by the loss (breakdown) of a particular module. Farah and Grossman (1997) as well as Rogers and Plaut (2002) have suggested that these category-specific deficits resemble the language processing problems seen in subjects with semantic dementia, a condition caused by a progressive, bilateral degeneration of temporal lobes. Coslett et al. (2002), on the other hand, described a patient with semantic dementia who presented with circumscribed deficits in the processing of selective categories. This patient’s comprehension and naming was significantly better for body parts than for animals. Interestingly, this observation stays in contrast to the research findings on aphasics, since in the present study an opposite dissociation was found (see Table 3). It is possible that these discrepancies may be due to a different etiology and the specific character of a brain damage. All of our patients sustained massive acute strokes that contrast with the slowly progressive degenerative changes typical for semantic dementia.

Another interesting characterization of the symptomatology of global as well as Wernicke’s aphasia was described by Goodglass and Wingfield (1993). These authors noted that aphasic patients had more problems with pointing to a picture depicting body parts than while asked to indicate a particular place on a map. Thus, this observation, together with our research findings, raise questions about the mechanisms underlying the impaired processing of names representing body parts seen in aphasic subjects. The ability to comprehend words denoting body parts may rely on sensory-motor associations in the gyri located next to the central sulcus. Since a relatively small number of fibers connects these gyri with the auditory cortex (Narkiewicz & Morys, 2001, p. 204), it is possible that even modest damage to these connections may result in problems with processing words denoting body parts.

The possible explanation proposed above, derived from the classical anatomical-connectionist model (Geschwind, 1965; see also Catani & ffytche, 2005), may additionally help to understand the nature of dramatic (since the most severe) problems of aphasic patients in auditory processing of words representing colors. It has been widely accepted that colors, being solely a visual stimulus, activate mainly an occipital cortex, a V4 region in particular. When the name of a color is presented auditorily, it first activates temporal regions, specifically Wernicke’s area (WA) encompassing the posterior part of the superior temporal gyrus in the left-hemisphere, and then the information is further forwarded to the V4 region. Therefore, the probability that damage to an associative fiber connecting the WA with the occipital cortex may result in severe deficits of auditory processing of color names is relatively high. Importantly, the defective comprehension of color names seen among our subjects was not due to low-level perceptual deficits (i.e., achromatopsia), since patients with difficulties differentiating colors or other sensory disturbances were not included in the study. The role of the WA in language comprehension has been also extensively studied by contemporary researchers, who concentrate, for example,
on recovery of single-word comprehension (Selnes, Knoopman, Niccum, Rubens, & Larson, 1983; Selnes, Niccum, Knoopman, & Rubens, 1984; see also Jodzio et al., 2005) or architecture of neural structures that become active when the lexical processes are started (Damasio, Grabowski, Tranel, Hichwa, & Damasio, 1996). There is strong evidence from these studies that normal word comprehension is dependent on a number of brain regions (together called a network) remote from the classic area of Wernicke (Mesulam, 1990).

The impaired ability of aphasic subjects to process color names could also be approached from the developmental perspective (Santos & Caramazza, 2002). Injury to the brain of an adult may be expected to disproportionately disrupt the comprehension of names which were acquired later in the ontogenesis. A similar principle (Ribot’s law) applies to memory processes, where the most recent events, in contrast to remote memories, are especially fragile and, therefore, may be easily lost and forgotten. Color names are difficult to learn, acquired relatively late, so that very young children often cannot correctly differentiate even between the basic colors. At the same period of childhood, significant changes are taking place in the architecture and function of the central nervous system; the number of synapses increases as well as the myelinization of nerve fibers progresses. In contrast, names of food, body parts, animals or vehicles are being acquired very early during the childhood and are usually well established by the age of 6 (Kielar-Turska & Bialecka-Pikul, 2000). Indeed, names derived from these semantic categories were also the easiest to comprehend by our aphasic patients. According to some researchers (for review see Forde & Humphreys, 2002), age of acquisition, however, is a complex factor with considerable within-subject variability and hence difficult to quantify and control.

In addition, our findings challenge the notion suggesting that the phenomenon of the “category-specific” disorders seen in aphasia may be an artifact of the methods used, name frequency, etc. (Gold et al., 2003; Laws et al., 2005; Montanes et al., 1995). In Polish, names denoting body parts represent a relatively more popular and more frequently used lexical-semantic category than do words belonging to other categories applied in this research (see Table 1). Despite this, names of body parts proved to be particularly difficult to process by our aphasic subjects. Moreover, it appears that the influence of frequency of a semantic category on its recognition seems to be rather minor, since we did not observe a significant correlation between ISD (a magnitude of dissociation between the comprehension of different lexical-semantic categories) and IWF (word frequency). Hence, our findings do not give credibility, at least in this instance, to the view that aphasic patients have less difficulties understanding more frequently used words. Similarly, the effect of visual complexity of task material on the performance was weak. Despite the fact that pictures of animals and means of transportation were the most complex in comparison with other kinds of pictures we used in the study (see Section 2.2), names of animals turned out to be the easiest category to understand across the group of aphasics.

The span of the disharmony (variability) of lexical-semantic disorders was, however, significantly correlated with a general ability to comprehend auditorily presented words as expressed by a total score obtained in the word discrimination task. Greater variability of the identification of particular categories was observed in patients who were more severely aphasic. In other words, the presence of semantic dissociations was related to the degree of comprehension problems. This finding may also have important practical and applicable implications, since it questions the clinical assumption about strongly generalized language impairment and poor prognosis in global aphasia. Traditionally, global aphasia refers to a condition in which all aspects of language output and comprehension are markedly impaired. However, in light of our results the term “global aphasia” does not capture the fact that there may be considerable variability within a given modality of processing, such as auditory comprehension. A similar view was also adopted by Deloche et al. (1981). It is also notable that observations described above could be used in a therapy designed to increase patients’ ability to correctly differentiate concepts. For example, better-decoded words (i.e., animals) could help to rebuild the ability of an aphasic subject to comprehend more difficult names (i.e., colors) by creating an automatic association between these lexical-semantic categories (i.e., a black cat, a red fox). Careful examination of individual patients and their heterogeneity will help to establish the best therapeutic program. Thus, the practical implications of our findings supplement the theoretical discussion among aphasiologists regarding the characteristics of linguistic processes in brain-damaged individuals (Goodglass, 1993).

This study has several limitations that need to be considered. Although the language competence of all participants was assessed with the BDAE, we cannot fully rule out the possibility that subtle perceptual/cognitive deficits might have contribute, at least in part, to the selective category-specific deficits of auditory comprehension. Another weakness of our study is homogeneous, i.e., only vascular, type of brain lesions observed in our patients, i.e., following a dominant hemisphere ischemic stroke. Paradoxically, this fact decreases external validity of the results from this study. Therefore, we would like to underscore the need for caution in generalizing these results on other neurological conditions leading to aphasia, such as neurodegenerative processes, brain tumors, TBI, etc. Additionally, standard quantification of
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References


