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Semantic operations and aphasia[1]

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Aim

The aim of this study is to investigate the ability of aphasics to perform specific semantic operations in a test. A test with two main parts, containing operations on semantic role relations and operations concerning type abstraction and specification, was given to a group of nine aphasics and a group of matched controls. The results are interpreted in relation to theories of semantic relations (Fillmore 1968, Allwood 1989), as well as theoretical assumptions concerning "abstraction", "contextualization", "automatic" versus "controlled" processing and "inhibition" versus "disinhibition".

Background

We assume that the human ability to use and combine words is based on, among other things, the ability to perform a set of semantic operations. Such operations include the abilities to associate by similarity and by role relations. They make it possible to delimit categories and types in some way and to determine their meaning in context.

We further assume that semantic operations can be performed automatically as well as in a more controlled manner and that both types are used in ordinary communication. We also assume that there can be a continuum with degrees of automaticity for the operations. We want to stress that semantic operations are normally performed in context and that they interact with the context in a way that affects their application in a crucial way.

When we turn to the semantic problems of aphasics, it is reasonable to see these problems as, at least partially, dependent on disturbances in the performance of semantic operations.

Several theories about the nature of semantic problems in aphasia have been presented. Some of the more prominent theories are Luria's theory of activitation and inhibition in semantic networks (Luria 1947) and Goldstein's theory of the loss of abstract attitude (Goldstein 1948).

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Specific hypotheses of the study are:

(i) that there is evidence for the role of activity as central in the semantic role structure
(ii) that all other roles are circumstantial and help to establish activity
(iii) that the role of result might be more important than other roles, since it can be used to identify the activity
(iv) that holistic situational anchoring is especially important for aphasics
(v) that abstraction poses problems and concretization will be used as strategy.

Method

Test

A test was designed, containing tasks which require several types of semantic operations, as specified below (3 items of each type):
(See table la below for the content of each task in Swedish and table lb for the English translation.)

A. Role relations

1. Given: Instrument	Task: construct Agent
2. Given: Instrument	Task: construct Activity
3. Given: Activity	Task: construct Result
4. Given: Activity	Task: construct Location
5. Given: Result	Task: construct Causal Activity

B. Types

Hyperonymy:	
6. Given: Two categories x and y	Task: Find common type
Hyponymy:	
7. Given: Category x	Task: Give a type of x.
Prototypicality:	
8. Given: Category x	Task: Describe a typical x.
Opposition:	
9. Given: Category x	Task: Give the opposite of x.

C. Meaning in context

10. Given: Metaphorical expression x	Task: Give the meaning of x.

Table 1a. Test of semantic operations (in Swedish)

A. Rollrelationer

1. Vem använder en	a) hammare b) pensel

c) högrep

2. Vad används en — a) spade b) spik c) trumpinne — till

3. Vad blir det när man — a) bakar b) ritar c) murar

4. Var — a) bakar b) ritar c) murar — man

5. Vad kallas det när man gör så att något blir — a) varmt b) kallt c) rent

B. Typer

6. Vad har — a) en tax och en schäfer b) en ros och en tulpan c) en mås och en sparv — gemensamt

7. Säg en typ av — a) hund b) bil c) fisk

8. Beskriv en typisk — a) hund b) stol c) tidning

9. Vad är motsatsen till — a) natt b) svart c) liten

C. **Betydelse i kontext**

10. Vad betyder a) — tåget kryper fram b) han är en åsna c) han ska få för gammal, os

Table lb. Test of semantic operations (English translation of Swedish original)

A. **Role relations**

1. Who uses a — a) hammer b) (paint-)brush (1) c) hayfork

2. What is a — a) Wade b) nail (2) c) drumstick — used for

3. What is the result when you (Lit. What does if become — a) bake b) draw c) build with bricks (3)

4. Where do you — a) bake b) draw c) lay bricks

5. What is it called when make something — a) warm b) cold c) clean

B. Types

6. What does — a) a dachshound and an alsatian have in common b) a rose and an tulip c) a seagull and a sparrow

7. Give a type of — a) dog b) car

	c) fish
8. Describe a typical	a) dog b) chair c) paper (4)
9. What is the opposite of	a) night b) black c) small

C. **Meaning in context**

10. What does	a) the train *crawls*-along mean b) he is *an ass* c) he is going to *get for old cheese* (5)

(1) The Swedish words (målare, pensel) are not morphologically related (unlike the English painter, paint brush).
(2) Not ambiguous in Swedish.
(3) The Swedish verb is "mura", which has a wider meaning than any corresponding English expression.
(4) The Swedish word covers "newspaper" and "magazine" only.
(5) The Swedish expressions which are translated literally mean a) move very slowly, b) stupid, c) cause for revenge.

Subjects

The test was given to nine aphasics: 4 aphasics with fluent speech (i.e., relatively effortless speech with normal speed) and mainly posterior left hemisphere lesions, and 5 aphasics with nonfluent speech and mainly anterior left hemisphere lesions. The following supplementary data for the aphasics were obtained: aphasia status, age, sex, time post onset, localization of brain damage and neurological status. The aphasics were chosen so that they would represent different aphasic symptoms and have sufficient auditory comprehension to be able to take part in the test. The test was also given to nine nonaphasic control subjects, who were matched to the aphasics for age, sex and education/ occupation.

The test was presented to the subjects orally and the responses were given orally. Repetition of tasks were allowed. The test sessions were audiorecorded and transcribed for analysis.

Results

I. Operations on semantic role relations

(i) General

All of the nine aphasics showed deviances from the control group in their answers to this part of the test. The controls always provided the intended target role, although, in a few cases, a specification or generalization, having the same role, was added. This type of addition was also made by the aphasics, but it was not considered as an aphasic feature, since it occurred in the control data.

Although the aphasics also most often provided the intended target role, they did not always seen able to perform a quick and specific operation going from one semantic role or role relation to another for a certain context. Instead, they searched among the roles in the total context, ending up with another role or role relation than the target or "triggering" the target via other roles. They also tended to add other roles, after having given the target. Both the actual route of association/activation and the appropriate stop on that route were, thus, affected.

(ii) Instrument to agent

The **instrument to agent** task gave some alternative responses from the aphasics. In 21 cases out of 27, direct operations were made with the intended target as result, but we can also see how the aphasics sometimes searched in the whole role structure. There are cases of both an inappropriate role given as answer and an appropriate role given, but with the addition of other roles or role relations (most often **activity**).

Examples:

	Question	Answer: aphasics:
Inappropriate role:	*Vem använder en hammare?*	*en spik*
	Who uses a hammer?	a nail
Generalized role:	*Vem använder en hammare?*	*en gubbe nä*
	Who uses a paintbrush?	an old man no
Inappropriate role + context:	Vem *använder en pensel?*	*ja de e* förstås *pensel å färg å måla tavlor å så*
Who uses a paintbrush?		yes it is of course paintbrush and paint paintings and so
Appropriate role + context:	*Vem använder en högrep?*	*en bonde han tar upp de tar å sätter upp en hässja eller nåt*
	Who uses a hayfork?	a farmer he eh takes it up takes and puts up a rack or something

(iii) Instrument to activity

If we look at how vulnerable the particular role relations in the test were, we find that going from **instrument to activity** seems to be easier than any of the other operations. All 27 tasks gave direct operations. This result is in accordance with the claim that actions (verbs) are central to the whole role structure, i.e. it would be natural that operations going from the periphery to the center of the role structure were more stable than operations going in the opposite direction. We do, however, find many additions of roles (8 cases); most often result is added. This points to a tendency to give a complete structure and/or a concrete context.

There can be different reasons why the **instrument to activity** operation is easier than the **instrument to agent** operation. The assumed central position of the activity is, of course, a candidate for an explanation. The roles are defined in relation to the activity. The answers also point to a lot of information being activated and a problem for some of the aphasics to give one role as response and suppress the rest of the information. It might also be the case that the agent role leaves the possibility open for more possible alternative words to fill the position than the activity, given the instrument as stimulus (i.e., there could be more possible agents than possible activities to choose from, given the instrument, and thus it would be a more difficult task to choose one of them). We do not find more alternative responses given to fill the agent role than for specifying the activity for aphasics or controls, but this does not exclude that a larger number of choices available for the agent role could be influencing the verbalization procedure.

(iv) Activity to result and activity to location

For both these operations, some of the aphasics, but not the controls, tended to give answers which were either ambiguous between the two roles result and location or replaced the one by the other. There were practically no additions of roles. In a few cases, other roles, such as agent or instrument, turned up as responses. It, thus, seems that going from activity to a specific role is not as easy as going from another role to activity. **Result** and **location** were given directly in only 17 out of 27 cases each.

The reason for the apparently easily made mix-up between result and location can perhaps be found in the similarities between the words and phrases filling these roles, which are in both cases located after the verb and can have similar meanings (Where you build and what you build can for, example, be the same thing). The eliciting questions for the two tasks had an initial question word, "vad" (= what) for result, and "var" (=where) for location. These question words can be sufficiently similar in spoken Swedish to possibly confuse some aphasics, even though the difference was emphasized in the pronunciation of the questions.

Examples:	(Q rep = question repeated by the examiner)
Question:	Answer: aphasics:
Vad blir det när man bakar?	*bakar i ugnen förstås bakar de blir bröd förstås*
What is the result when you bake?	bake in the pan of course bake it becomes bread of course
Vad blir det när man ritar?	*ritar en penna å såna saker en gång till*

	IQ rep/ ritade i pappret såna saker de e IQ rep/ pappret förstås IQ rep/ fdrdigt förstås
What is the result when you draw?	draw a pen and such things once more /Q rep/ drew in the paper such things that is sure that is /Q rep/ the paper of course /Q rep/ finished of course
Var ritar man?	*en tavla*
Where do you draw?	a painting
Var murar non?	*ja ja ha gjort de skorstenar*
Where do you lay bricks?	yes 1 have done that chimneys

(v) Result to causal activity

Does the assumption of the activity role as structurally central, also from the cognitive point of view, hold, when we consider the finding that the operation result to causal activity posed problems for the aphasics. 22 out of 27 tasks gave direct operations (2 of these responses also included the instrumental object). Quite often we found the response **object or instrumental object + activity.**

Here we have to consider, that the task was to go from result in the form of an adjective signifying a state, i.e., from a resulting property of something to a causal activity. The aphasics seemed to be more dependent on specifying the object having the property or, more often, the **instrumental object,** before they gave the causal activity, thereby differing from the controls. Once again, the whole context, or at least more of the context, was more often described by the aphasics, than by the

controls.
Example:

Question:	Answer: aphasic:
Vad kallas det när man gör så att något blir kallt?	*de mat eller nåt sånt eller sätter i kylskåpet eller nåt sånt*
What is it called when you make something cold?	it food or something like that or put in the refrigerator or something like that

II. Operations on semantic categories

The required operations were of four types:

(i) Give a subordinate category for a given category

(ii) Give a superordinate category for two given categories

(iii) Give a prototype description for a given category

(iv) Give the opposite category for a given category.

(i) Subordinate category

The easiest of the tasks was to give a subordinate category. All of the aphasics performed this task without hesitation, except one aphasic, who was unable to give two of the three responses.

(ii) Superordinate category

Giving a superordinate category turned out to be much more problematic than giving a subordinate category. Whereas the controls made this operation easily and directly, the aphasics, in many cases, went via the explicit mentioning of common and/or non-common features of the two given categories, before naming a superordinate category. (This is not incorrect, given the question, but unnecessary, as we can see from the responses of the controls.)

Examples:

Question:	Answer: controls and aphasics:
Vad har en schäfer och en tax gemensamt?	*de är hundar*
What does a dachshound and an alsatian have in common?	they are dogs
	Answer: aphasics:
	en nos en svans /Q rep/ hund
	a nose a tail /Q rep/ dog
	de e en stor å en liten hund it is a big and a small dog
	fyra ben förstås liten å stor hund four legs of course small and big dog

We also find a few cases, where aphasics go via features and also via one of the given categories or even a subcategory to a given category.

(iii) Prototype description

A prototype description could be made of a more or less specific and concrete prototype. The controls gave their descriptions as features, except for one control, who gave a subcategory prototype and then its features. For the aphasics, this task was more difficult than expected. Only four of the aphasics managed any of the tasks and only one aphasic succeeded on all three tasks. In four of the totally eight responses from aphasics, an explicit and concrete subcategory prototype was named before its features were given and one of the aphasics had to be prompted with a repeated question before going on to give the features.

Example:

Question:	Answer: aphasic:
Beskriv en typisk hund.	*ja eh de e en tax eh men eh liten korta ben lång nos öron eh hängande öron och uppåt stående svans*
Describe a typical dog.	yes eh it is the dachshound eh but eh small short legs long nose ears eh hanging ears and upstanding tail

Also here, we find that the aphasics sometimes needed to be explicitly more concrete in their answers, establishing the specific object before talking about its properties. In order to generalize from object categories in the superordinate category task above, we could see that aphasics explicitly specified features of the objects.

An easily available route of operation seems to be:
concrete object > features > generalizations

(iv) Opposite category

This task was not very difficult for the aphasics, but off target responses still occurred.

Examples:

Question:	Answer: aphasics:
Vad är motsatsen till natt?	*ja de e som de e nu sol dagen*
What is the opposite of night?	yes it is like it is now sun the day
Vad är motsatsen till svart?	*röd vit*
What is the opposite of black?	red white
Vad är motsatsen till svart?	*ljus*
What is the opposite of black?	light

In some of the responses, properties (or features) of the opposite category or a context seem to have been activated first. The controls always gave the expected responses.

III. Contextual meaning (in metaphors)

Two aphasics had some problem with items of this task and one of the aphasics declared that this was the sort of thing he was completely unable to understand. The patients who had problems were either unable to answer or answered slightly off target.

Examples:

Question:	Answer: aphasics:
Vad betyder "han är en åsna"?	*man e kritisk*
What does "he is an ass" mean?	you are critical
Vad betyder "han ska få för gammal ost"?	*de e ungefär samma man e kritisk*
What does "he is going to get for old cheese" mean?	it is about the same you are critical

IV. Quantitative summary

The results, in terms of how many problems each aphasic had on each type of task, are summarized in Table 2. The controls had no problems in the test.

Table 2. Fluent (F) and Nonfluent (NF) aphasics: number of problems on each type of task.

Semantic roles (15 tasks)	Types (12 tasks)		Contextual meaning (3 tasks)		Total (30 tasks)			
Aphasic	N	%	N	%	N	%	N	%
1 F(MIX.)	6	40	2	17	0	0	8	27
2 NF	1	7	0	0	0	0	1	3
3 F	9	60	6	50	1	33	18	60
4 F	6	40	6	50	3	100	15	50
5 NF*	7	47	-	-	-			-
6 NF	2	13	6	50	0	0	8	27
7 F	3	20	3	25	0	0	6	20
8 NF	2	13	2	17	0	0	2	13
9 F	6	40	9	75	2	67	17	57
Total N	44		34		6		77	
Mean %		33		35		25		30

[*Aphasic 5 was exhausted by the first tasks and could not continue after item 6 (subcategory). His results were excluded in the totals and means.]

Nonfluent aphasics:
The clearly nonfluent aphasics, numbers 2 and 8, had very few problems, whereas aphasic 6 mainly had problems with type operations. The difficulties of the nonfluent aphasics 5 and 6 could be due to the extent of their lesions, which was in both cases considerable. It is, however, clear that mildly nonfluent aphasics were not much affected with problems concerning semantic operations.

Fluent aphasics:
Since the severity of the aphasia has to be considered, we cannot compare fluent to nonfluent aphasics in general. We can only note that the fluent aphasics in this study all had problems with semantic operations.

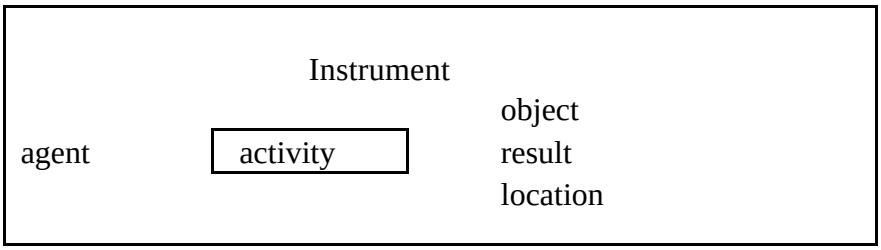
In summary, the following seems to hold in our data:
a) Aphasia which is severe-and-fluent causes serious problems with semantic operations.
b) Aphasia which is either moderate-and-fluent, or severe-and-nonfluent causes a great deal of problems with semantic operations.
c) Aphasia which is moderate-and-nonfluent causes some, but only few, problems with semantic operations.

Discussion

Some general findings were that with regard to semantic type operations, the aphasics had almost no problems performing subcategorization/concretization operations. When asked to perform abstracting/generalizing operations, they tended to go indirectly, via common and non-common semantic features, thereby making explicit steps in the operations. Abstracting/generalizing operations clearly caused more problems than specifying/concretizing operations. (We here take specification to be an operation directed towards the more concrete.)

In the role construction tasks, **activity** seems to be easy to reach. Going from instrument to activity was the easiest operation concerning semantic role relations (100% direct operations for the aphasics). Going between other roles or from activity to other roles appears to be harder (63 - 8 1 % direct operations for the aphasics). Addition of roles in order to provide a more holistic context often occurs; especially **activity and result** are used, but also **agent and instrument.** The aphasics, given a resultative property, tended to give an object having that property or the instrument for producing the property, before giving the required causal activity, which then did not cause any problems (e.g. "hot"- stove"- "heat"). Concrete instances, thus, seems to be a help in some semantic role operations. Contextual anchoring by constructing other relevant roles, e.g. **result to activity,** also seems to help.

It seems then that a "role field", where an activity determines other semantic roles, combined with a tendency to identify concrete role-fillers, given abstract ones (such as properties) and a tendency to add roles in order to contextualize the operation is compatible with the behavior of the aphasics.



If we look at our hypotheses for this study, we find that they are all supported by the results. We find a *central position for **activity*** and *more circumstantial function for the other roles* and, *possibly, a special function for **result**,* which is the role most often added to activity. We further find *holistic situational anchoring,* we find *abstraction problems* and *tendencies to concretize,* thus landing a kind of support for Luria's and Goldstein's theories.

When we turn to the problems of **automatic** versus **controlled** processes and activation versus **inhibition,** we find more than one possibility. The search via concretization, specification and contextualization can be seen as the application of controlled strategies for word search, caused by a lack of any activation of the target. But it can also be a more direct consequence of a disturbance in selective activation, causing the off target semantic roles and semantic features, and possibly the context as a whole, to be activated or, rather, disinhibited.

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