Implications of aphasia on abstract and concrete noun processing

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Introduction

Concrete nouns are generally processed faster and more accurately than abstract nouns in various cognitive tests. Possible explanations for this 'concreteness effect' include:

•Whereas abstract nouns mainly activate left hemisphere 'language areas' around the Sylvian fissure, concrete nouns activate more widespread brain areas, including bilateral posterior association cortices where sensory experiences are represented [1,2].
• A larger amount of contextual information facilitates the processing of concrete nouns [3].
•Concrete nouns have a larger amount of stable semantic features [4].

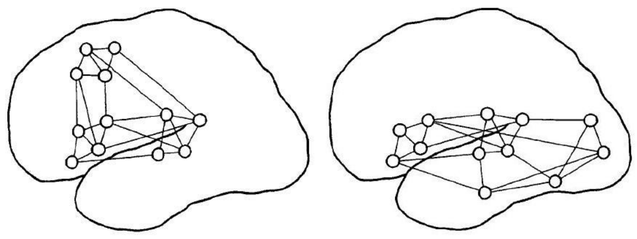

Figure 1: Cortical representations of 'action words', e.g. movement verbs (left) and 'vision words', e.g. concrete nouns (right) [2].

The present study

The goal of the present study was to investigate abstract and concrete noun processing in four Swedish subjects with aphasia; three with left perisylvian (frontoparietal and temporoparietal) lesions, and one with left occipital lesions (Tab. 1).

Subject	Age	Onset of aphasia	Diagnosis	Latest CT-scan	Localization of lesions
1 (female)	41	1989 04 25	Cerebral infarct	2000 08 22	LH frontoparietal, mainly frontal
2 (female)	66	2004 10 08	Cerebral infarct	2004 10 27	LH frontoparietal, mainly frontal
3 (female)	31	2007 02 12	Cerebral infarct	2007 10 30	LH temporoparietal
4 (male)	76	2004	Cerebral infarct	2004	LH occipital

Table 1: Aphasic subjects.

An enhancement of the normal 'concreteness effect' was expected in the aphasic subjects. Both the fact that the concrete nouns to a higher degree have sensory-motor representations and the fact that many of these representations are bilateral would be likely to contribute to a relatively better preservation of concrete nouns in aphasia. This was hypothesized to be reflected as:

•lower test scores for the abstract nouns in the aphasic subjects
•relatively longer access times for word associations for abstract nouns in the aphasic subjects

Method

Noun comprehension was tested with a multiple-choice test where the task was to choose definitions for abstract/concrete nouns* from four alternatives consisting of other nouns (Fig.2).

9) SKALLERORM 'RATTLESNAKE'	7) AMBULANS 'AMBULANCE'	32) LÄTTNAD 'RELIEF'	36) VÄRDE 'VALUE'
☐ reptil 'reptile'	☐ fartyg 'vessel'	☐ befrielse 'alleviation'	☐ krav 'claim'
☐ mask 'worm'	☐ apparat 'device'	☐ förståelse 'understanding'	☐ sätt 'way'
☐ insekt 'insect'	☐ fordon 'vehicle'	☐ förälskelse 'love'	☐ del 'part'
☐ ödla 'lizard'	☐ automat 'machine'	☐ belåtenhet 'contentment'	☐ pris 'price'

Figure 2: Examples of concrete (9, 7) and abstract (32, 36) multiple-choice questions. The questions were always read aloud embedded in a phrase with 'is', e.g. 'RATTLESNAKE is... a reptile, a worm, an insect, a lizard?'

*The nouns used in the tests were obtained from the ones listed for concreteness values in the MRC Psycholinguistic Database [5]. The concrete nouns were words for natural and man-made objects. The abstract nouns were terms describing emotions, human interaction and other abstract states.

A word association test, where the task was to provide verbal associations for concrete and abstract nouns, was also performed. Both tests were presented auditorily and recorded.

Data analysis

Word association access times were measured using the sound-editing software Audacity (Fig. 3).

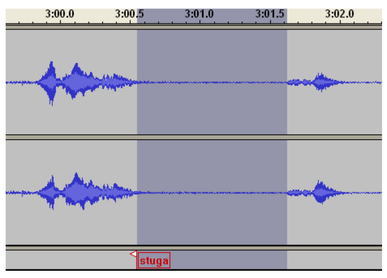

Figure 3: Waveform of a concrete test word 'stuga' (cottage) and an association word 'hus' (house). The silent periods between words were marked so that the exact access times could be seen.

The test scores and access times of the frontoparietal and temporoparietal subjects were compared with those of twelve healthy controls. ANOVAs were performed with participant group (aphasic/control) as a between-subjects factor and concreteness (abstract/concrete) as a within-items factor.

Results

•The controls all had close to a full score on the multiple-choice test (Tab. 2; Fig. 4)
•Subjects 1-3 all had lower scores on the abstract questions (Tab. 2)
•Subject 4 scored lower on the concrete questions (Tab. 2)
•Mean access times for word associations were longer for the abstract nouns for all participants (Tab. 3).

Test scores	Subject 1	Subject 2	Subject 3	Subject 4	Mean: 1-3	Mean: Controls
Concrete nouns	26.0	25.0	29.5	23.5	26.8	29.5
Abstract nouns	21.5	13.0	23.5	30.0	19.3	29.6

Table 2: Multiple-choice test scores.

Mean access times	Subject 1	Subject 2	Subject 3	Subject 4	Mean: 1-3	Mean: Controls
Concrete nouns	3.7	8.8	2.3	11.4	4.9	2.1
Abstract nouns	14.2	12.3	5.3	12.2	10.6	6.7

Table 3: Mean access times.

In the multiple-choice test, an interaction of group and concreteness was present $F1(1,13) = 37.847$, $p < 0.001$; $F2(1,58) = 19.590$, $p < 0.001$, with test scores being relatively lower in the abstract condition for aphasic subjects with frontoparietal and temporoparietal lesions (Fig. 4).

No interaction between concreteness and participant group was found in the access times $F1(1,13) = 0.406$, $p = 0.535$; $F2(1,58) = 2.717$, $p = 0.105$. (Fig. 5)

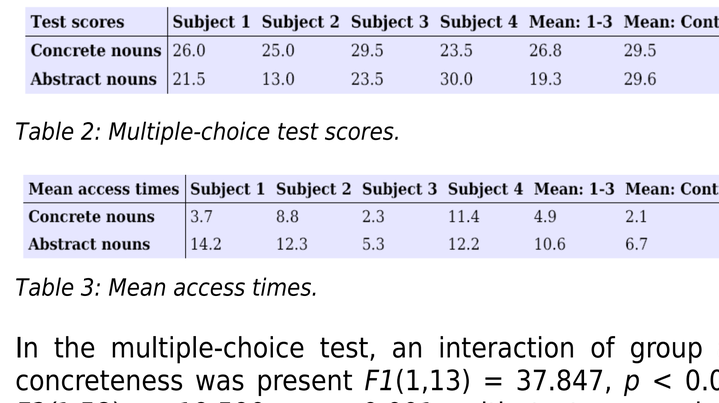

Figure 4: Mean multiple-choice test scores for healthy and aphasic participants. Figure 5: Mean word association times for healthy and aphasic participants.

However, qualitative differences between the groups were present, with the abstract nouns eliciting some types of associations in the aphasic subjects which were not present in the controls, for example:

•perseverations (Tab. 5)
•associations from a fixed semantic field (Tab. 4)
•newly constructed antonyms (Tab. 5)
•failure to access any association at all

Associations from a fixed semantic field	Subject 3
lojalitet 'loyalty'	jag 'me'
undantag 'exception'	odd
depression 'depression'	MAS
moral 'morale'	Lund
reaktion 'reaction'	stroke 'stroke'
hat 'hatred'	MAS
fördel 'advantage'	logoped 'speech therapist'
entusiasm 'enthusiasm'	NAMN (NAME)
omständighet 'circumstance'	läkare 'doctor'
rädsla 'fear'	inte prata 'not to speak'
framtid 'future'	arbeta 'work'
optimism 'optimism'	jag 'me'
tendens 'tendency'	målmedveten 'goal-oriented'

Table 4 (left): Associations about the stroke, the hospital and personal characteristics, produced by subject 3.

Perseverations and new constructions	Subject 2
reaktion 'reaction'	sant 'true'
ärlighet 'honesty'	sant 'true'
fördel 'advantage'	sant 'true'
osäkerhet 'uncertainty'	sant 'true'
samvete 'conscience'	osant 'untrue'
kris 'crisis'	osant 'untrue'
passion 'passion'	opassion* 'unpassion'
förolämpning 'insult'	osant 'untrue'
ideal 'ideal'	sant 'true'
lydnad 'obedience'	olydnad 'disobedience'
humör 'mood'	ohumör*'unmood'
rädsla 'fear'	orädd 'unafraid'
ansvar 'responsibility'	oansvarig 'irresponsible'
framtid 'future'	orädd 'unafraid'
optimism 'optimism'	orädd 'unafraid'
tendens 'tendency'	otendens* 'untendency'

*Table 5 (right): Perseverations and newly constructed antonyms (marked with *) produced by subject 2.*

In contrast, most of the concrete nouns elicited associations which were semantically related to the test nouns and independent from the associations given earlier in the test (in subjects 1-3).

Subject 4 had difficulties with the concrete nouns, especially the ones describing living things, e.g. animals and plants (Tab. 6).

No association	Non-specific or unusual associations
sköldpadda 'tortoise'	katt 'cat' → kvinna 'woman'
limousin 'limousine'	krokodil 'crocodile' → trädgård 'garden'
smaragd 'emerald'	pincett 'tweezers' → huvud 'head'
nejlika 'carnation'	jordgubbe 'strawberry' → mat 'food'
järn 'iron'	blomkål 'cauliflower' → mat 'food'
varg 'wolf'	choklad 'chocolate' → mat 'food'
vulkan 'volcano'	gurka 'cucumber' → mat 'food'

Table 6: Word associations for concrete nouns given by subject 4.

Discussion

The results of the present study indicate that:

•Abstract noun processing is more affected than concrete noun processing by left hemisphere frontoparietal and temporoparietal lesions
•Concrete noun processing is more affected by left hemisphere occipital lesions.

Highly abstract nouns can be assumed to be more context-dependent. To comprehend an abstract noun, it has to be put in context, which frequently consists of other abstract words. Concrete nouns, on the other hand, have a more constant meaning across contexts, and are more strongly associated with non-linguistic, sensory-motor meaning representations, such as visual, auditory and tactile experiences.

Occipital lesions, which affect the primary visual cortex, may have the consequence that some vision-related meaning representations become unavailable, thus disturbing the processing of concrete nouns.

Further research

A more fine-grained investigation of the processing of different types of abstract and concrete nouns could be carried out. There may for example be differences in the processing of emotionally charged and neutral nouns, assuming that the first involves limbic structures, e.g. the amygdala, whereas the second does not.

Left hemisphere occipital lesions may implicate *optic aphasia*, a syndrome where the naming of visually presented objects is impaired, whereas naming from verbal definitions and from other modalities such as touch, sound and taste are well-preserved [6]. Since subject 4 has problems accessing associations for verbally presented concrete nouns, it would be interesting to see if he, like optic aphasia patients, more easily can access the nouns when experiencing sounds or other sensory experiences associated with them.

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