A Multimodal Communication Aid for Global Aphasia Patients
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Abstract
This paper presents the basic rationale behind the development and testing of a multimodal communication aid especially designed for people suffering from global aphasia, and thus having severe expressive difficulties.

The principle of the aid is to trigger patient associations by presenting various multimodal representations of communicative expressions. The aid can in this way be seen as a conceptual continuation of previous research within the field of communication aids based on uni-modal (pictorial) representations of communicative expressions. As patients suffering from global aphasia seldom have identical symptoms, the focus of this paper is placed on the development of a highly dedicated communication aid adaptive to the individual patients’ needs. The paper investigates whether or not such a highly dedicated communication aid based on multimodal representations of communicative expressions can be used to support patients with global aphasia in communicating by means of short sentences with their surroundings. Only a limited evaluation is carried out, and as such no statistically significant results are obtained. The tests however indicate that the aid is capable of supporting a global aphasia patient in participating in conversations based on short sentences - which otherwise would be impossible without the use of a communication aid.

1. Introduction
It can be argued that aphasia patients can be categorised according to the severity of their functional handicap using the following categories: 1. mildly aphasic, 2. moderately aphasic and 3. severely aphasic encompassing global aphasia where a major part of the expressive functions are damaged.

Category 1 and 2 encompass patients who are capable of communicating with their surroundings at a comprehensible level. These patients can often be aided by means of access to rehabilitation tools, specifically designed with the aim of either enhancing their damaged cognitive skills or attempting to ‘move’ cognitive functionalities from damaged areas to healthy areas of the brain [1].

Category 3 encompasses patients who are incapable of communicating in a meaningful way with their surroundings. It is very difficult to treat these patients with the same type of rehabilitation tools as applied for aphasic patients of category 1 and 2. Aids for category 3 patients require that they are designed for allowing communication between the patient and a care-giver/therapist or a family member who is highly aware of the missing communication capabilities of the specific patient.

1.1. Previous Studies
As aphasic patients seldom have identical symptoms, a dedicated communication aid is required for each patient. Today mainly rehabilitation tools for patients from category 1 and 2 exist; a selection of such tools has previously been subject to a study in [2]. In contrast the amount of communicative aids for category 3 patients is very limited. Research within this area has however been applied to some extent. For example, the system “C-VIC” [3] relies on the principle of associations in the mind of patients with expressive difficulties. The patient observes a picture and associates it with a thought. By viewing a series of single pictures it is hoped that the “correct” picture triggers a desired association (i.e. state of mind) and that this picture then is chosen by the patient to represent the communicative message wanted or part of this.

1.2. The need for Multimodality
Not all patients suffering from global aphasia may however be expected to benefit from communication based on uni-modal schemes. Better associative results may possibly be obtained by using multi-modal schemes implementing multiple representations (e.g. animations, pictures, sounds etc.) in support of missing skills in communication.

With the introduction of small-size powerful desktop computers and their capacities for large data storage and multi-modality, possibilities have now emerged for conducting research in new multidisciplinary areas that may lead to communication aids for the group of disabled citizens who are not able to communicate meaningfully even with their closest relatives in daily environments.

This paper reports about ideas and results from a preliminary study aimed at the establishment of a multimodal communication aid for patients suffering from global aphasia, hereafter called AssociaCom [4]. The paper outline is the following. Section 2 describes the architecture and details of the modules of AssociaCom. The results from a first limited test are presented in section 3 and 4. These results are then finally discussed in section 5.

2. Details of AssociaCom
AssociaCom is built as part of an architecture in which a number of presentation media is a central part and designed on such a basis that it primarily enables the patients to create associations by being presented to a (multimodal) variety of real-life situations that individually, or in combination, allow the patients to express their communication in an unambiguous way. AssociaCom is designed in such a way that its communication features flexibly and adaptively are easily defined during one or more setup sessions in which the patient and a care-giver both are participating.

These considerations have motivated this research to focus the design considerations on the applicability of methods and techniques often used in connection with spoken language technology where words/items used as database entries have a direct analogy to concepts that are often applied in treating
aphasic patients and where these analogies therefore may be transparently applied in the structure of AssociaCom. A person viewing the following synonymous representations: the ‘picture’ of a snoring person, the acoustic ‘sound’ of a snoring person, the written text ‘snoring’ and a ‘video clip’ of a sleeping person, may associate some of or all of these items with the same meaning, namely a person who is sleeping. A set of items that are conceived as having the same meaning – observed by the aphasic patient - together form a database entry and can be stored as such for later easy retrieval. As will become clear later, the database of AssociaCom is populated during one or more setup sessions in which the patient and care-giver work together. The structure of the AssociaCom database is shown in Figure 1.

Figure 1: Structure of the AssociaCom database. Each entry is represented by a varying number of modalities.

2.1. Multi-modal representation.

In [5] it is argued that when dealing with Augmentative and Alternative Communication (AAC) systems the main objective of structuring the database is to enable the user to access the desired communicative elements quickly and easily whenever needed in a conversation. According to [6] the two most common ways of strategically organising pictures in the context of a communication aid is to arrange them in accordance with a semantic categorisation or in a set of visual-spatial orientated schemes. Furthermore [6] states that semantic categorisation is the most commonly used of the two strategies, even though this requires the user to master abstraction as a skill.

AssociaCom utilises a many-to-one strategy as illustrated in Figure 1, where e.g. pictures are given in combination with other suitable selected modalities (i.e. sounds, animations etc.) and together constituting a database entry associated with communicative expressions that are used in the patients’ daily life. As organisation strategy, a semantic categorisation scheme is used. All entries of the database are in this way grouped according to general semantic categories corresponding to routine communicative expressions (for example domestic or personal). An example of this strategy is shown in Figure 2, where each expression constituting a higher level of abstraction for other expressions is denoted as a category, and each isolated expression not being connected to other expressions (i.e. due to relations of abstraction) is denoted as a term, this way constituting a tree structure with a top level and a varying number of sub-levels. As an aphasic patient may be incapable of manoeuvring within a tree structure, the database can – at the setup session(s) – be populated with all expressions at level 0 (top level), see Figure 2.

Figure 2: Example of a semantically categorized database.

2.2. User Interface

The fact that global aphasia often has a great impact on the patients’ cognitive as well as motor skills and that this is varying from patient to patient, makes it highly needed to provide AssociaCom with easy configurability to support the patients’ individual behaviour and capability. It is of major importance that the functionality of the user interface of AssociaCom is easy to comprehend/understand and that its output presentations (e.g. ‘drawings’, ‘pictures’, ‘sound segments’, ‘synthetic speech’ etc.) are natural for the patient, taking into consideration her/his special situation. Any communication requires the full attention of the patient and he or she shall spend minimal mental resources on the actual interaction with AssociaCom. The explicit need for a simple and intuitive user interface of AssociaCom is thus evident.

2.3. Database Maintenance

Easy maintenance of the AssociaCom database by a non-expert care-giver is enabled by allowing for easy selection of relevant modalities for each database entry. The care-giver will conduct the first setup of the database. This will be based on communicative experiments in which representations of database entries most suitable for the individual patient and the optimal structuring of these is determined. The caregiver is furthermore required to administrate the database on a continuous basis.

2.4. Components of AssociaCom

AssociaCom consists of two components; a patient client and an administrator client.

2.4.1. Patient Client

The patient client provides the aphasic patient with the possibility of choosing among multimodal representations of communicative expressions occurring in conversational situations. During the selection process the patient may be in one of two situations, where he or she has

a) An idea of which category or term an expression belongs to (multiple-view)
b) No idea of which category or term an expression belongs to (single-view)
To assist the patient in these situations, the patient client offers two selection modes:

a) **Multiple-view mode**
The time required by the patient for selecting an expression is minimised by presenting a number of expressions simultaneously.

![Figure 3: Screen shot of the patient client operating in multiple-view mode.](image)

This is illustrated in Figure 3, showing a screen shot from AssociaCom in multiple-view mode. The patient can in this mode directly select categories or terms from the database, hereby concatenating a sentence of individual communicative expressions. During this selection the patient can freely navigate through the different levels of the database as exemplified in Figure 2.

b) **Single-view mode**
Each representation of a given expression is traversed in a cyclic order in a timed way. A screen shot from AssociaCom in Single-view mode is shown in Figure 4.

In addition to the timed presentation of the individual expressions contained in the database, the patient can explicitly reject individual categories or terms in order to speed up the search process. When presented to a relevant category or term, the patient can select this as in the multiple-view mode.

![Figure 4: Screen shot of the patient client operating in single-view mode.](image)

An automated mode-shifting scheme has been implemented for the purpose where it is not known beforehand whether or not the patient communicates optimally by using the multiple- or single view mode, as illustrated in Figure 5. As shown in this figure, the database level is increased when a category is chosen, corresponding to a branch being followed, see Figure 5. As the size of the database varies depending on the specific needs of different patients, a situation may arise in which a large database exists, resulting in relatively long time spent searching within this. For this reason the database is searched in an order corresponding to the frequency in which entries have been selected during past use. When operating in multi-view mode, the Patient Client is furthermore implemented to be showing, as a maximum, the six most frequently selected entries of the database at all times, see Figure 3.

![Figure 5: The automated mode-shifting scheme of the patient-client.](image)

2. **Administrator Client**
In order to provide administrators of AssociaCom with efficient means for adding, removing and editing entries from the database, as well as adjusting patient specific settings (e.g. adjustable time durations for presenting selected entries from the database) an administrator client is developed. As an administrator can be expected to cover a wide range of persons ranging from computer novices to experienced computer users, special attention is placed on the development of a simple graphical user interface as well as ease of use.

3. **Test of AssociaCom**
In order to evaluate AssociaCom in terms of usability and performance, a preliminary test was conducted using a number of schemes containing open questions.

3.1. **Procedure**
Carrying out an evaluation of the patient client based on explicit responses from patients suffering from global aphasia may be very difficult due to obvious communicative difficulties, and may even lead to situations of ambiguous responses if doing so. Due to this, an evaluation strategy based on expert statements from speech therapists familiar with this patient group was chosen for the test. Two speech therapists were in this way asked to go into details and elaborate on sessions of interaction between actual patients and the patient client.

The overall aim of the tests was to uncover whether or not the three design objectives of AssociaCom stated in Table 1 had been met. As no specific quantitative scale can be applied for the evaluation of these objectives, the entire test was based on a qualitative evaluation sheet containing a series of open questions to be answered by the two speech therapists.
### Table 1: The objectives of AssociaCom.

<table>
<thead>
<tr>
<th>Objective</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - Speed</td>
<td>Use of the patient client must be fast.</td>
</tr>
<tr>
<td>2 - Ease of use</td>
<td>The patient client must be easy to use.</td>
</tr>
<tr>
<td>3 - Self confidence</td>
<td>The patient client must support the self confidence of the patient using it.</td>
</tr>
</tbody>
</table>

3.2. Subjects

Initially, a test session involving participation by two subjects suffering from global aphasia and currently individually associated with the two involved speech therapists was scheduled.

However, due to personal circumstances one of the aphasic patients cancelled the participation. One of the speech therapists offered to put herself in the place of the aphasic patient. The other speech therapist assisted the aphasic patient in testing the patient client as planned.

### 4. Results

On the basis of the written answers to the open questions the following was indicated for the objectives of AssociaCom, as shown in Table 2.

<table>
<thead>
<tr>
<th>Objective</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - Speed</td>
<td>It was indicated that this, though not unconditional, had been accomplished to an acceptable extent. In conversational situations based on physical objects within the vicinity of the patient, or in situations involving short messages to be formulated, it would be faster for patients to use pointing at these objects or other forms of gesticulation. For other situations of communication, AssociaCom does seem to induce a time-related advantage.</td>
</tr>
<tr>
<td>2 - Ease of use</td>
<td>It was indicated that once the patients were instructed in the use of AssociaCom, this usage would not constitute any major problems. The caregivers however required the presence of a user manual in order to be capable of giving these instructions.</td>
</tr>
<tr>
<td>3 - Self confidence</td>
<td>It was indicated that this to some extent had been achieved. This was based on the fact that the patient using AssociaCom possibly would be better capable of participating in conversations than without the usage of a communicative aid. The increased participation in “normal” everyday situations can be assumed to indeed support the self confidence of the patient using the aid by possibly reducing the social isolation or sense of helplessness as perceived by the patient.</td>
</tr>
</tbody>
</table>

### 5. Conclusions

Due to the limited testing no absolute conclusive statements can be deduced from the preliminary test results. This research however shows that within the area of communicative aids for people suffering from global aphasia even these preliminary efforts are indicated to be of help at the level of short-sentence communication.

It also shows that the aid does not substitute communicative situations where the patients are able to use simple pointing at objects within close vicinity, or generally used gestures and mimic.

Further evaluations will be required in order to produce statistically significant results, and to do further research aimed at aiding global aphasia patients in their daily communication and alleviating their social isolation.

### 6. Acknowledgements

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### 7. References