1. Introduction
Augmentative and alternative communication (AAC) encompasses methods that replace/complement speech of individuals with complex communication needs.

**Shortfall:** Current AAC systems are expensive and predominantly rely on the interpretation of purposeful gestures; however, such methods limit the solutions in terms of versatility and portability.

2. Novelty and Assumption
Enable the communication of the patients in Intensive Care Units, Locked-in-syndrome, or on ventilator support using a validated and affordable communication system via the usage of modulated breathing patterns.

**Assumption:** All these individuals can breathe spontaneously, hence breath can be used as a system activation method.

3. Methods
A 10 second breathing pattern could represent a whole word or phrase, rather than just a single letter code (in comparison to past studies).

**Tested setups**
Air tube connected to a low-pressure sensor, processing electronics, and a PC/mobile interface to collect breathing patterns.

The method was also tested with a cardioid microphone to evaluate a cheap/easy alternative solution.

**Participants and Subject Tests**
Total: 39 healthy, non-speech disabled volunteers (2 experimental protocols). Ethical approvals were obtained prior to the start of the study. Each subject chose 4 patterns and provided 15 repetitions of each to train the system and recall sentences.

**Processing**
Initial tests were processed offline using MATLAB. The classification of the patterns was tested using several machine learning algorithms and classifiers. Real time processing is under development for the use with the mobile application.

4. Design and Development

**Breath**

**Current System Setup**

**Training Mode:** Teaching the system the breathing patterns and the associated words

**Live Mode:** System waits for a user’s breath input to speak out the associated words

5. Results and Analysis
The highest mean reliability of the current system interpretation is 93%.

The highest mean reliability of the system using a microphone is 86%.

- The second chart shows the distribution of correct classifications using our current setup of detecting breath vs. a microphone.

**Classification Accuracies of the Tested Setups**

<table>
<thead>
<tr>
<th>Tested Setup</th>
<th>Classification Accuracy (%)</th>
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</thead>
<tbody>
<tr>
<td>Current Sensor Setup</td>
<td>100%</td>
</tr>
<tr>
<td>Microphone Setup</td>
<td>86%</td>
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</tbody>
</table>

**Classification and System Learning Results**

<table>
<thead>
<tr>
<th>Test Method</th>
<th>Percentage Success Rate (%)</th>
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<tbody>
<tr>
<td>DTW</td>
<td>90%</td>
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6. Conclusion and Current Work
- The intervention requires only an ability to breathe spontaneously.
- The system is language independent, with multiple spoken words or sentence responses.
- Currently working on increasing the flexibility of the system to support the needs and capabilities of different users.
- Currently working on the system validation by the intended users.

References