Concept for semantic error analysis in a mobile application for speech and language therapy support

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Aphasia and aphaDIGITAL

Aphasia facts

- Aphasia is an acquired language disorder due to focal brain injury (a stroke in 80% cases)
- Annually, 270.000 people suffer a stroke in Germany
- 30% of all stroke survivors experience initial aphasia, chronic deficits - in 20% of cases
- Predominant age group is 50-59 years old
- Generally affects more men than women (up to three times more)
- Affects all language modalities
- Word-finding problems are present in the vast majority of aphasia cases

References

Project motivation

- Patients with aphasia do not have access to sufficient speech and language therapy
- High-frequency exercise treatment is for the success of the therapy and promotes the communicative participation of the patients
- Efficiency of digital therapy solutions is proven
- Absence of German apps with automated speech analysis and individual verbal feedback/ avatar

Main features

- Interactive exercise guidance by avatar (verbal instruction and feedback)
- Therapeutic avatar function (audition, mouth picture)
- Acquisition and integration of all production and reception modalities by the use of artificial intelligence (e.g., speech recognition and natural language processing)
- Exercise setting based on ICF (International Classification of Functioning, Disability and Health) dimensions
- Individualization of exercise setting, exercise material, task content and presentation options
- Low-threshold access to technology through intuitive usability and operation

Close Orthographic Matches Method

General procedure

- Speech input recognized with the help of an ASR solution vs the target word
- Character error rate (CER) threshold provisionally set to 0.54
- Threshold not passed + deviating transcription: close orthographic matches are searched in a list of 239,650 German words (Python difflib)
- N close matches are subject to path-based similarity analysis via GermaNet, the semantically closest match is taken for further considerations

Automatic assumptions from orthographically deviating forms

Deviating transcription	Word meant by the speaker	Word assumed from the word list search (n – number of close matches)			
		n = 20, n =30	n = 50	n = 100	n = 500
Mölch	Milch	Milch	Milch	Milch	Milch
Oransch	Orange	Organschaden	Organschaden	Organschaden	Orange
Oransche	Orange	Orangenschale	Flansch	Orange	Kirsche
Zwinen	Zwiebel	Zwinge	Zwinge	Zwinge	Zwiebel
Prot	Brot	Brot	Brot	Brot	Printe
Preis	Reis	*Reis* not in close matches			*Reis* in close matches
Babrika	Paprika	Paprika	Paprika	Paprika	Paprika
Rot	Brot	*Brot* not in close matches			
Jese	Käse	Jersey	Wesen	Wesen (despite Kekse)	Gemüse

Semantic Error Analysis and Feedback

Picture to name: 

Target word: Käse (cheese) Semantic subcategory: Milchprodukt (dairy product) Semantic category: Lebensmittel (food)

	Recognised text		Word and semantic matching		Feedback
ASR	Kese (deviating transcription) ☒ Phonemic/phonetic error (CER = 0.25)	CER threshold	☒ Pronunciation match ☑ Word match ☑ Subcategory match ☑ Category match		You are close! Look at the written word and read it carefully: „Käse". *(detailed feedback based on the error type (insertion/deletion/substitution) is under development)*
ASR	Joghurt (yoghurt) ☒ Semantic error (CER = 1.75)	GermaNet	☒ Pronunciation match ☒ Word match ☑ Subcategory match ☑ Category match		Not quite right. It is a different type of *dairy product*. Please try again.
ASR	Mölch (deviating transcription) ☒ Phonemic/phonetic + semantic error (CER = 1.25)	GermaNet	☒ Pronunciation match ☒ Word match ☑ Closest match: Milch ☑ Subcategory match ☑ Category match		Did you mean *milk*? Not quite right. It is a different type of *dairy product*. Please try again.
ASR	Milchprodukt (dairy product) ☒ Semantic error (CER = 3)	GermaNet	☒ Pronunciation match ☑ Hypernym list match ☑ Subcategory equal ☑ Category match		Almost there. What type of *dairy product* is it?
ASR	Edamer (Edam) ☒ Semantic error (CER = 1.25)	GermaNet	☒ Pronunciation match ☑ Hyponym list match ☑ Subcategory match ☑ Category match		A bit too specific. Edam is a type of …
ASR	Fleisch (meat) ☒ Semantic error (CER = 1.5)	GermaNet	☒ Pronunciation match ☒ Word match ☒ Subcategory match ☑ Category match		It is a different type of *food*. Please try again.
ASR	Mond (Moon) ☒ Semantic error (CER = 1)	GermaNet	☒ Pronunciation match ☒ Word match ☒ Subcategory match ☒ Category match		I am sorry, *Moon* is not correct. Please try again.