Querying Repetitions in Spoken Language Corpora

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Abstract

In this paper, we present a tool for searching repetitions in interaction corpora. Our approach based on the MTAS-technology uses common search token indices to retrieve repetitions from spoken language transcripts in a dynamic way. The CQP Query Language and a graphical user interface menu with extensive settings specially designed for conversation analysis researchers allow to find repetitions of complex linguistic forms in various pragmatic contexts. Furthermore, the web application enables searching for repetition constructions that may contain synonyms and hyp(er)onyms coming from GermaNet or from custom-defined word lists uploaded to the tool.

1 Introduction

Repetitions of words, phrases or whole utterances are of immense importance for everyday linguistic practices, from facilitating language acquisition of children (e.g., Keenan, 1977; Tarplee, 1996; Lester et al., 2022) and L2-learners (e.g., Brown, 1998; Ghazi-Saidi and Ansaldo, 2017) to adopting specific pragmatic functions in everyday interaction like securing understanding or keeping up the current speaker's right to speak (see Wang, 2005; Mattes, 2014; Deppermann and Helmer, 2013). Repetitions can also take on particular functions in storytelling e.g. as resumptions (see Wong, 2000), and facilitate fluent narration (see Tannen, 1979), as well as contribute to sequence organization and display trouble with the action of a prior utterance (cf. Antaki, 2014; Barth-Weingarten, 2011; Betz et al., 2013; Robinson, 2013; Robinson and Kevoe-Feldman, 2010; Selting, 1987; Stivers, 2004). Also worth mentioning are research traditions relating to social accommodation theory (Giles and Powesland, 1997) and the interactive alignment model (Pickering and Garrod, 2004) often targeting repetitions in their methodological approach.

Repetitions in spoken language have been widely studied in various disciplines. However, many questions have so far been examined primarily for the English language and have not yet been investigated systematically based on the peculiarities of German. Furthermore, different types of this phenomenon could be analyzed more deeply and comparatively, especially on corpora with video data and in further interaction contexts (e.g. in conflict talks).

Up to now, the search for repetitions in conversation analysis and interactional linguistics was largely done manually by reading transcripts, which is a very time-consuming task. It requires maximum concentration and is often prone to overlook instances, e.g. when looking for repetitions located at a large distance from each other. Sometimes, the desired repetition should fulfill many requirements at the same time (self-repetition, initiated by others, realized by children etc.), which is a further challenge for human ability to recognize repetitions in transcripts at first sight. That's why it is important that corpus analysis platforms used by interactional linguists also provide methods for querying repetitions.

2 Related Work

Several matching algorithms for the automatic recognition of lexical and even structural repetitions have already been developed and applied in psycholinguistics in corpus-based studies where repetitions serve as one of quantitative measures of mutual understanding and language coordination (cf. e.g. Brodsky et al., 2007; Grigonytė and Björkenstam, 2016; Wirén et al., 2016; Lester et al., 2022; Vogel, 2013; Reverdy and Vogel, 2017a; Reverdy and Vogel, 2017b; Danescu-Niculescu-Mizil et al., 2012; Reitter and Moore, 2014; Placiński and Żywiczyński, 2023). In the field of conversational speech analysis and linguistic tool

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development, the automatic detection of repetitions is not yet that widespread. Only individual solutions exist for certain types of repetitions like an automatic method proposed by Bigi et al. (2014) to retrieve other-repetition occurrences in spontaneous French dialogues. This algorithm is published with a set of other annotation tools under the name SPPAS[1] and can be downloaded and used for different languages.

Two other corpus platforms that should be mentioned here are CLAPI[2] (Baldauf-Quilliatre et al., 2016) and Lexical Explorer[3] (Lemmenmeier-Batinić, 2020). CLAPI offers a dedicated tool for querying repetitions online and allows to find segments of one or multiple tokens both of the same and another speaker. However, the search is limited to individual transcripts; searching for repetitions in the entire corpus is not possible. The repetition search provided in Lexical Explorer aimed to facilitate lexicographic work with spoken data. For this reason, this tool only provides searching for one or two word repetitions of the same speaker, thereby making use of pre-calculated data.

Querying repetitions on the fly is also possible: Some online platforms make use of special query language (QL) elements such as quantifiers or global constraints to allow for a systematic search for user-defined forms of repetitions, cf. e.g. CQPWeb[4] (Hardie, 2012), Kontext[5] (Machálek, 2020) and OpenSoNar[6] (van de Camp et al., 2017). However, these systems use data models that are unsuitable for spoken language corpora, because they e.g. are limited in representation of speaker overlaps and time-based annotations, which leads to significant loss of information relevant for spoken language research. Moreover, the QL itself is restricted to structures which can be described by regular grammars. Many repetition structures, however, are on a higher level of the Chomsky hierarchy, i.e. they are context-free or even context-sensitive.

In this paper, we propose a new method for querying repetitions in spoken language corpora by using full-text search indices, that is, to our knowledge, designed and implemented for the first time. Furthermore, we combined the use of a QL with a graphical user interface specially developed for the conversation analysis.

3 Data

The development of the repetition tool was primarily motivated by the need to work with the interaction corpora from the Archive for Spoken German (Archiv für Gesprochenes Deutsch, AGD[7]). The most important representative of these corpora is FOLK[8] (Forschungs- und Lehrkorpus Gesprochenes Deutsch 'Research and Teaching Corpus of Spoken German', Schmidt, 2023; Reineke et al., 2023). This is a constantly growing corpus of currently about 350h of audio and video recordings of authentic spontaneous conversations from various private, institutional and public communication situations (around 3,3 million transcribed tokens). Extensive speaker and speech event metadata of this and other corpora from the AGD, their digitized transcriptions in ISO 24624:2016 aligned with the audio/video signal as well as multi tier linguistic annotations (normalization, part-of-speech (POS) tags, lemmatization, phonological annotations, speech-rate information, code-switching, discourse comments etc.) enable diverse linguistic investigations. However, the systematic repetition research was until now limited because of the lack of suitable annotations on the one hand and on the other hand because the QL used for searching these corpora in the current search interfaces DGD[9] and ZuRecht[10] does not support syntactic elements allowing to build a query for complex repetition structures.

4 Approach

The tool presented in this paper is a product of the close collaboration between conversation analysis researchers and software developers at the Leibniz-Institute for the German Language (Institut für Deutsche Sprache, IDS). It is implemented as a part of ZuRecht (Figure 1), which is a web-based application for querying spoken language

[1] https://sppas.org/

[2] Search and browsing platform for French interaction corpora, http://clapi.icar.cnrs.fr

[3] Platform for browsing and filtering quantitative data of the FOLK- and GeWiss-corpora, https://www.owid.de/lexex/

[4] A CWB-based corpus search platform, provides access to the Spoken BNC2014, https://cqpweb.lancs.ac.uk

[5] A NoSketchEngine-based search platform for the CNC-corpus containing both written and spoken language data, https://lindat.mff.cuni.cz/services/kontext

[6] A BlackLab-based search platform for the CGN-corpus, https://opensonar.ivdnt.org/

[7] https://agd.ids-mannheim.de

[8] https://agd.ids-mannheim.de/folk.shtml

[9] https://dgd.ids-mannheim.de

[10] http://zumult.ids-mannheim.de/ProtoZumult/jsp/zuRecht.jsp

data. ZuRecht was designed and implemented in the ZuMult-project[11] and allows to query interaction corpora in the ISO 24624:2016 format. The search functionality is built on MTAS (Brouwer et al., 2016) – an open-source search engine framework that builds on Lucene und extends it with a QL familiar to corpus linguists. MTAS was originally developed for querying richly annotated texts. In ZuRecht, it is first used for querying data of spoken language. It was adopted to the specifics of spoken language, thus allowing now to search in ZuRecht for typical spoken language phenomena like speaker changes and overlaps, pauses and other para-verbal events, e.g. laughter or coughing. Frick and Schmidt (2020) and Frick et al. (2022) provide more information about MTAS and explain why this search engine was chosen for the ZuRecht implementation. Compared to other Lucene-based solutions for querying corpora with linguistic annotations, the MTAS advantage lies in its configuration file that can be easily modified without programming knowledge and used to parse corpus files in a custom-defined way allowing to specify what information from ISO/TEI transcripts should be indexed and how. The data is then stored according to the MTAS specific prefix-suffix concept[12] and is saved in a forward index created by extending the Lucene Codec. A modified version of CQP QL, that is internally converted to Lucene queries, can be used to retrieve the search index for terms and their positions in the appropriate corpus document. We use this forward search index to compute repetitions in our corpora in a dynamic way, i.e. the search is performed within a reasonable response time after the desired repetition type is specified and submitted by the user.

4.1 Search Engine (SE)

According to the ZuMult object-oriented corpus data model (Batinić et al., 2019; Schmidt et al., 2023), all components of spoken language corpora (audio, video, metadata, transcripts, annotations, but also their integral elements like tokens, spans, speaker contributions etc.) are defined as objects with certain behavior and particular relations among them. We extended this concept by providing an additional *Repetition*-object. After collecting user configuration settings, the client creates an xml representation of the repetition object, and sends it to the back-end.

The search method in the Java back-end that can be called through RESTful web services is designed to allow different QLs and multiple SEs be used to perform repetition searches in the future if necessary. The API ensures also a high flexibility in specifying parameters passed to the search method, e.g. it also accepts parameters that can be processed only by one or the other SE. This can be, for instance, the search by synonym lists or the use of special search indices allowing to ignore punctuation during the search process. The search for repetitions builds on full text indices. First, the positions of all spans matching the query string and containing only word tokens realized by one speaker are retrieved. Then, the word tokens in the directly following N positions after the match are fetched directly from the search index and compared with the match itself, where N is the distance window specified by the user.[13] If a token sequence is identified as a repetition, the user-specified conditions are checked in the next step, e.g. whether the repetition comes from the same or another speaker, or whether the repetition is located within an overlap, etc. Everything happens within the search index by retrieving required annotation values for certain positions. The access to the search index is parallelized and all hits are written into a temporary document. After the search, they are sorted and returned to the client in the requested volume.

4.2 User interface

The search for repetitions starts with the selection of a corpus from the corpus list in the left-hand column of the user interface (cf. Figure 1), whereby cross-corpus searches are also possible. The green bordered text input field at the top of the search form can be used to specify the element to be repeated. It is possible just to type in a single word or a word sequence or alternatively to use CQP-based query syntax to define more complex elements that contain e.g. regular expressions,

[11] https://zumult.org/

[12] For more details on the prefix-suffix model see Frick and Schmidt (2020) and MTAS documentation under https://textexploration.github.io/mtas/index.html

[13] If the context becomes too large, the tool finds too many false positives, i.e. repetitions that are not interesting for the research (e.g., being many consecutive utterances with the copula *sein* 'to be'). In turn, a more restrictive context leads to many false negatives. An evaluation based on examples from articles on repetitions as well as on self-generated collections of examples showed that repetitions of tokens occur on average 10-15 tokens after the utterance of the original element. Therefore, and for better performance, the maximum possible distance between repetitions is currently set to 20 tokens.

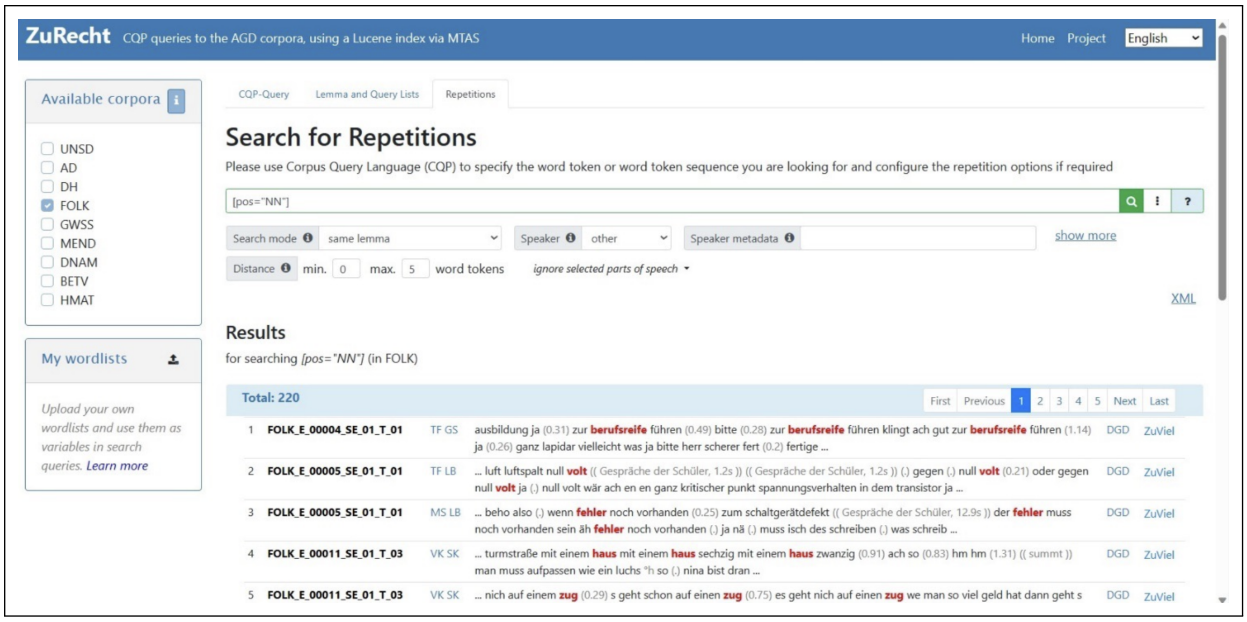

Figure 1: Repetition search tool (part of ZuRecht).

precedence operators, specifications for POS tags and/or speaker metadata constraints like in the following example looking for repetitions of all response particles (NGIRR) with the exception of all forms of 'hm' in telephone conversations (German 'Telefongespräch'):[14]

```
[pos="NGIRR" & !norm="(hm)+"] within
<e_se_art="Telefongespräch"/>
```

A query builder integrated into the search input field helps to formulate CQP-based search queries and lists specification values of available annotation and metadata categories. The repetition search tool offers various search options:

- The "Search mode" menu specifies the method how repetitions should be identified, e.g. what token form (transcribed, normalized or lemmatized) should be compared and whether GermaNet (Version 17.0, Kunze and Lemnitzer, 2002; Henrich and Hinrichs, 2010) or custom defined synonym lists should be involved in the search process.
- The "Speaker" drop-down list allows to choose whether the speakers should repeat themselves or be repeated by another speaker.
- Furthermore, the minimum and maximum of distance between repetitions can be specified. Some POS like articles or hesitation phenomena can be selected to be ignored when measuring the distance.
- The "Distance to speaker change"-option allows to specify at what distance from the previous/following speaker change the repetition should be found.
- The option "Speaker overlap" can be used to find only those repetitions that occur inside or outside of speaker overlaps. It can be useful in order to find reduplicated reception signals while the dialogue partner is still speaking or conversely to find examples outside of speaker overlaps as they are better suited for further phonetic and prosodic analyses.
- The "Multiword repetition" defines whether the token order of a repeated multi-word expression may vary or should be the same.
- The "Context (left/right)"-option allows to apply CQP for specifying patterns of elements preceding or following the repetition.
- In addition, it is possible to specify separate settings for a second repetition when searching for an element repeated at least twice (Figure 1), e.g. to investigate repetitions produced in order to get more precise information about the object mentioned before by the first speaker where the first speaker then provides an explanation by repeating the object again.

The repetition search results are listed as a KWIC (KeyWord-In-Context) concordance that can be customized in terms of the context size and the number of results per page. Both the searched

[14]The metadata key *e_se_art* stands for German *Art des Sprechereignisses* 'type of speech event' and is used in FOLK.

element and its repetition are marked in red (see Figure 1). Individual hits can be viewed in a larger context, listened to and downloaded in various formats (iso/tei, .exb, .eaf, .textGrid etc.) incl. audio/video excerpts if required.

5 Use Case

In expert-novice-interaction, repetitions are a regular part of defining or negotiating the meaning of terms and concepts; either technical terms or terms with a situational meaning that needs to be clarified. Often, experts do not repeat a 'problematic' term exactly, when explaining its meaning, but instead substitute it with expressions that denote the same or related concepts. For example, Quasthoff and Hartmann (1982) and Helmer (2020) show that, amongst others, naming synonyms and hyp(er)onyms as well as other terms with a specific semantic relation is one recurring practice of defining expressions. This occurs in different sequential contexts, sometimes after repair initiations, sometimes self-initiated. Research can still be deepened with regards to the type of expressions repaired and which types of expressions are used to substitute them, with regards to sequential organization and also with regards to a comparative analysis of different types of the other-initiation of such substitutions (e.g. different ways to display trouble with expressions and the relation to following substitutions). These types of 'repetitions' can be found by using GermaNet integrated into the new search tool. The option "same lemma (use GermaNet only)" combined with the search query

```
[pos="(NN)"] within <ses_rolle_s =
"(Ausbilder|Coach|Dozent|Tutor|Trainer|
(L|.+l)(eiter|ehrer))/in"/>
```

will return repetitions containing synonyms and hyp(er)onyms defined in GermaNet and restricted to speakers who are teachers, tutors and other experts[15]. Further settings specified in the repetition search form determine that the repetitions should be realized by the same speaker and within the maximum distance of 20 tokens by ignoring articles (ART), interjections (ITJ), responsive/reception signals (NGIRR), hesitations (NGHES), abortions (AB) and other non-words (XY, e.g. stuttering).

Executed on the FOLK corpus, the search query returns[16] 553 hits containing several pieces of evidence for repetitions by substitution. We can find here repetition constrictions, in which, e.g.,

- a dialect word is substituted by standard language expression. Example: *käschtel* (a dialectal diminutive for 'box') substituted by *rechteck* ('rectangle').
- a phrasal characterization is substituted by the fitting technical term. Example: *diese pedale (. . .) hier unne* ('this pedal down there') followed by *bremspedal* ('brake pedal').
- a technical term is substituted by a more common term. Example: *gynäkologe* ('gynecologist') substituted by *frauenarzt* (literal translation: 'women's doctor').
- more common terms are substituted by technical terms. Example: *vollziehende und richterliche gewalt* ('executive and judicial power') substituted by *judikative exekutive und legislative* ('judiciary executive and legislative').

As these examples show, the GermaNet-function of our tool can be helpful to find the targeted repetition constructions and to systematically investigate semantic, sequential and other pragmatic aspects of using synonyms as substitutions.

6 Conclusion

In this paper, we presented a new tool for searching repetitions in spoken language corpora. We combined the CQP QL with an extensive user interface filter allowing for queries that could not be expressed in the standard CQP syntax yet and making repetition structures that were hitherto accessible only with great difficulty amenable to systematic exploration, and fruitful and variable research.

7 Limitations

The strength of the tool presented in this paper is searching for repetitions in a dynamic way as an alternative to enriching corpora with space- and time-consuming annotations of repetitions. Using full-text indexes allows direct navigation to the corpus locations that may contain a desired repetition form, which is faster than searching repetitions directly in

[15] Ausbilder –'instructor'; Dozent – 'lecturer'; (L|.+l)(eiter|ehrer) matches 'Leiter' ('director'), 'Lehrer' ('teacher') and all compounds with them. The metadata key *ses_rolle_s* stands for German *Rolle des Sprechers im Sprechereignis* 'role of speaker in speech event' and is used in FOLK.

[16] Search time: approx. 26 sec. executed on the VM with 4 vCPU, 8 GB RAM, 75 GB HDD, CentOS 7 64-bit

each XML transcription file. However, searching for complex repetition forms (i.e. those with multiple conditions or with long word sequences) in a large corpus like FOLK often need to be restricted to certain corpus parts (e.g. just one conversation type) in order to be performed in a user-friendly time[17]. As future work, we plan to implement more parallel processes to optimize the speed of the tool by dividing the search indices in smaller components and by using special frameworks (e.g. CompletableFuture[18]).

8 Ethical Considerations

Data that can be accessed through the repetition search tool underlay data protection policies applied in AGD. This mainly includes three aspects: 1) Informed consent has been obtained for collection and publication of data; 2) Access to the search tool requires user registration and is granted for research, teaching and study purposes only; 3) Data parts that would enable the immediate identification of the persons involved in the conversation (such as locations names, phone numbers, etc.) are de-identified in the audios and replaced by pseudonyms in the transcripts. The collection and presentation of the spoken data that can be accessed through the tool presented in this paper was approved by institutional data protection officer.

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[17] Ideally, the search queries should take a few seconds. In the field of conversation analysis, researchers are often willing to accept longer search times to retrieve hits from large corpora. However, search queries that take longer than three minutes are, in our view, unacceptable.

[18] https://docs.oracle.com/javase/8/docs/api/java/util/concurrent/CompletableFuture.html

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