A text-writing system for Easy-to-Read German evaluated with low-literate users with cognitive impairment

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Abstract

Low-literate users with intellectual or developmental disabilities (IDD) and/or complex communication needs (CCN) require specific writing support. We present a system that interactively supports fast and correct writing of a variant of *Leichte Sprache* (LS; German term for *easy-to-read German*), slightly extended within and beyond the inner-sentential syntactic level. The system provides simple and intuitive dialogues for selecting options from a natural-language paraphrase generator. Moreover, it reminds the user to add text elements enhancing understandability, audience design, and text coherence. In earlier development phases, the system was evaluated with different groups of substitute users. Here, we report a case study with seven low-literate users with IDD.

1 Introduction

Recent studies report that more than 10 percent of German-speaking adults have low literacy skills (cf. Anke Grotlüschen et al., 2020). People with intellectual and developmental disabilities (IDD) and/or complex communication needs (CCN) often belong to this group (Light et al., 2019; Grotlüschen and Buddeberg, 2020; hereafter referred to as *the target group*, or simply *the users*).

Leichte Sprache (*LS;* easy-to-read German), a simplified variety of German, was developed for the target group as part of the plain language movement of the 2000s (cf. Inclusion Europe, 2009; BITV2.0, 2011, Netzwerk Leichte Sprache, 2013, or Bredel and Maaß, 2016).

Inclusion necessitates technical assistance to barrier-free participation in all social spheres (Hirschberg and Lindmeier, 2013). In the following, we investigate the extent to which *natural language processing* (NLP) can support the users while writing. An increasing variety of writing-support systems based on *natural language generation* (NLG) attract attention (for their prospects, see, e.g., Dale and Viethen, 2021; for approaches based on deep learning, see Otter et al., 2021). Adaptive behavior like automatically modifying the written text incurs the risk that users—due to low-literacy—do not carefully check whether or not the changes express the intended meaning. Missing is a text base produced by the target group. In general, text in LS is produced by authors proficient in standard German [1]. Thus, suggestions by the system that are automatically extracted from given LS text might not be perceived as helpful but irritating, let alone unintentionally patronizing. In addition, interactions with the user pose additional challenges, such as designing an accessible interface (cf. Nganji and Nggada, 2011). In essence, supportive interaction patterns should not overtax the user.

In the present paper, we describe *EasyTalk* for fast, correct and reader-centered writing in *Extended Leichte Sprache* (*ELS*; Harbusch and Steinmetz, 2022; ELS extends LS in several respects, for instance, with high frequent constructions from spoken German that incorporate the target group's ways of articulating their thoughts; for previous prototypes of *EasyTalk*, see Steinmetz and Harbusch, 2020; 2021a/b). On the sentential level, a natural-language paraphrase generator suggests correctly inflected word forms. It pursues the overall correctness and completeness of the sentence and provides the correct German word ordering. In order to improve text-understandability and text-coherence over the entire text, *EasyTalk* reminds the user to add *audi-*

[1] They may be supported by rule-based validation tools (for LS, see, e.g., languagetool.org/de/leichte-sprache/) or automatic text-simplification (cf. Ebling et al., 2022; for English, see, e.g., paperswithcode.com/task/text-simplification)

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ence-design features within a clause (Bell, 1984). The user is invited to clarify the discourse structure by adding connectors (inspired by *Rhetorical-Structure Theory* (RST); see Hovy, 1988 and Mann and Thompson, 1988), thus explicitly marking the relationship between the simple clauses. (SVO order is mandatory in declarative main clauses of (E)LS).

In the following, we first summarize the state of the art in writing-support systems. Then, we outline *EasyTalk*'s mechanisms for supporting text-production both within and between sentences. In Section 4, we report the results of a case study we recently conducted with seven users from the target group. The results are compared with observations from earlier evaluations with other user groups, in particular with L2 learners of German. The paper ends with a discussion of open issues and desirable future work.

2 Writing support systems for users with IDD and/or CCN

This section summarizes the state of the art in writing systems focusing on German where particular problems arise from rich morphology and free word ordering. In Section 2.1, we present symbol-based systems that go beyond needs-based, functional communication supporting the expression of personal thoughts in the context of social closeness and sharing information (cf. Light, 1988). In Section 2.2, we outline text-based systems designed for the target group. Finally, we address systems for teaching text-writing.

2.1 Symbol-based writing systems

Augmentative and Alternative Communication (AAC) offers a wide range of support to people with CCN, for example, the use of symbols as visual representation of a word or idea (cf. Figure 1, Figure 2, and Figure 3[2]). Technical solutions for symbol-based AAC are increasingly available on mainstream devices like smartphones and tablets (Ascari, 2018), ranging from simple concatenation of symbols for needs-based, functional communication (see, e.g., the popular free apps *SymboTalk*[3]

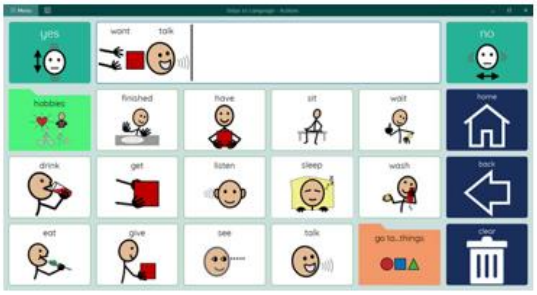

Figure 1: A simple *Mind Express* symbol-grid.

Figure 2: A complex *Mind Express* symbol-grid where symbols are grouped and colored by category (e.g., verbs in green, nouns in orange).

Figure 3: A *Mind Express* alphabet page, offering symbols and letters to access words.

and *LetMeTalk*[4] for German) to complex (commercial) systems (cf. Lancioni et al., 2019, for a thorough survey). Although language support through linguistic processing by computer is increasingly in demand, the full potential of support through NLP for AAC is not yet exploited (Waller, 2019).

Gateway[5], *Mind Express*[6] and *TD Snap Core First*[7] offer a representative sample of widely provided features in complex, commercial symbol-based AAC systems. Primarily, these systems enable users to participate actively in real-time spoken dialog. In addition, they aim to help users to increase the grammatical and lexical diversity

[2] The three snapshots (accessed 17.02.2022) are taken from: www.jabbla.com/en/mind-express/ and www.jabbla.com/en/tutorials/steps-to-language-the-alphabet-page-in-level-1/.

[3] www.symbotalk.com/

[4] apps.apple.com/de/app/letmetalk-gratis-aac-talker/id919990138

[5] www.gatewaytolanguageandlearning.com/

[6] www.jabbla.com/en/mind-express/

[7] de.tobiidynavox.com/pages/td-snap-core-first#

of their written output. For writing, they provide basic linguistic support, such as adaptive word prediction and automatic inflection of simple sentence constituents. The more complex the linguistic variety, the stronger the need for grammatical knowledge on the part of the users. For instance, they may have to specify the correct word endings manually due to the lack of correct predictions by the systems.

As shown in Figure 1 and Figure 2, the systems typically offer customizable *grid layouts* of varying complexity, suitable for different access methods like eye-control, touch, or scanning[8]. Grid cells may contain symbols, words, letters, and function buttons like 'undo' or 'enter menu'. Accordingly, activating a grid cell can select a word, lead to another grid page containing more words of a certain category, or access grammatical functions, respectively. Users with basic spelling skills can use a mixture of letters and symbols to choose the words (cf. Figure 3).

Generally, these systems presuppose individualized teaching and year-long practice (see, e.g., McNaughton et al., 2008, and Waller, 2019, addressing various challenges). Progression from easier to more advanced keyboards is supported by the constant positioning of the typed sentence. The layout examples in Figure 1 and Figure 3 place the current sentence prominently at the top. Preceding sentences are only visible to advanced users (e.g., Figure 2, two consecutive sentences are displayed in the white box). By design, the writing support focuses on the sentence level.

2.2 Text-based writing support systems

Writing instruction with appropriate technology positively impacts people with IDD (Smith et al., 2020). Modern text editors implement barrier-free access by features like read-aloud functionality. The database by the German foundation *barrierefrei kommunizieren!*[9] lists systems for users with disabilities: standalone systems like *Kurzweil3000*, *Penfriend*, and *MULTiTEXT;* and next-word predictors like *WoDy*, *EMU*, and *FTB-TippFixx* that can be integrated with MS Word and other text editors to support the user.

Text-based writing support suits users with a modest level of computer skills, who can write short sentences in a (simplified or customized) text editor. A variety of visual highlightings and color encodings (e.g., color keys for different word types, parts of a sentence, punctuation symbols) facilitates navigation through the text. Flexible read-aloud functions reproduce the written text letter by letter, word by word or sentence by sentence (with or without punctuation marks), thus providing memory support and spelling assistance. On demand, all systems employ grammar checkers. Adaptive word predictions (partially for customizable vocabulary) are usually offered in the form of word lists searchable via hotkeys for quick selection. However, all systems present the users with an empty page. The process of building up the text structure is not supported.

2.3 Teaching text-production

In German-language primary and secondary schools, the method of the *Schreibwerkstatt/Schreibkonferenz* 'writing workshop' is widely applied (see, e.g., Reichardt et al, 2014, for a broad survey). The students learn how to introduce every protagonist of a story in a way that allows the reader to identify them while the story progresses. Also taught is the appropriate use of elements of text coherence, discourse structure, and audience design. At the sentence-formulation level, students are instructed to integrate sets of short, choppy sentences into longer, more effective ones (cf. *sentence-combining techniques;* see Nordquist, 2018, for an online introduction; Ney, 1980, for the history, and Saddler and Preschern, 2007, for the school context). Beside computer systems for the above-mentioned topics[10], there is a wide range of NLG systems for automatic text production, such as parameterized interactive storytelling by Lukin and Walker (2019), or interactive story modeling using recurrent neural networks by Fortuin et al. (2018). However, none of these systems are available in German. Moreover, there is no straight-forward way to equip any of these systems with an interface appropriate for the target group.

3 Text-writing assistance by *EasyTalk*

EasyTalk targets the creation of text beyond the genre of simple chat messages with an interface that does not overtax the user. In particular, it aims

[8] A scanning system iterates sequentially through all options until the user instructs the system to stop and select.

[9] www.barrierefrei-kommunizieren.de/datenbank/

[10] See, e.g., the *WritingPal* (www.igi-global.com/chapter/the-writing-pal/88184)

to alleviate the need for a lengthy learning and practicing period. All barrier-free concepts cited previously should be available. To interlace with the user's word-by-word formulation process, we suggest a bottom-up approach employing a natural-language paraphrase generator on the sentential level (cf. Section 3.1). To meet the concepts the target group is likely to use to express their thoughts, the generator is based on an extension of LS. As the extension does not deviate from the mandatory SVO word order in declarative main clauses, we propose to add discourse-structure clues between sentences (see Section 3.2) to improve text coherence. We demonstrate that all dialogues with the user can be restricted to easy wording and simple choices—irrespective of the complexity of the linguistic task.

3.1 Text functions

EasyTalk's user interface comprises three layers embedded in the Menu Panel: Top: Text Panel; Middle: Sentence and Connector Panel in alternation; Bottom: Next-Word Panel (see the two snapshots in Figure 4 depicting that either the Sentence Panel or the Connector Panel is active).

Eventually, the users can export their texts from *EasyTalk* with or without symbols via the option '*save text'* from the meta-level Menu Panel (cf. A in a gray hexagon in the lower snapshot). In addition, this panel offers various settings (B) providing further customization features, which we will not discuss here due to space limitations. For instance, extending the vocabulary or changing the symbols enable personalization of the system.

Framed by the Menu Panel, the top layer displays all previously typed text (e.g., finishing the sentence currently in the upper snapshot updates the Text Panel in the lower one). The user can activate the read-aloud functionality by clicking on a sentence (cf. C in a green pentagon in the lower snapshot). For backing up the train of thoughts, the user can scroll through the text (D). If desired, lines from the text can be erased (E).

Next, we explain our approach to the design of the individual writing panels.

3.2 Within-sentence support

At the sentential level, *EasyTalk* aims at fast and correct writing. The user is supported by: symbols for finding words in their correct spelling, the correct inflectional endings in any sentential context, mentioning all obligatory arguments according to the verb-valency frame, and maintaining the correct word ordering. On the premise of supporting the user according to the document planning, constituents can be freely entered in any desired order. However, guidance by a default execution-strategy is always active. To fulfill audience design[11] aspects, *EasyTalk* reminds the user to add attributes such as time and place. All interactions with the user are presented in an intuitive manner.

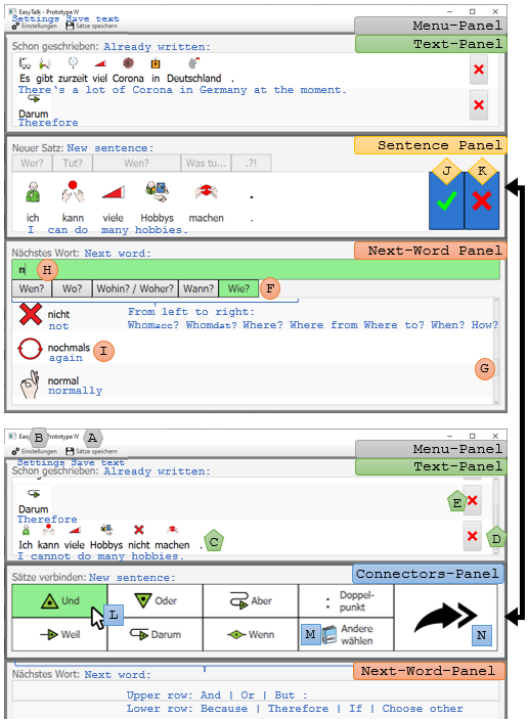

Figure 4: Two consecutive snapshots of *EasyTalk's* overall interface. Top: typing the sentence *Ich kann viele Hobbys nicht machen*; Bottom: adding the connector *Und* after the sentence is finished. The interface elements are explained in the text.

To this end, *EasyTalk* employs a natural-language paraphrase generator originally designed for L2 learners of German (cf. the *COMPASS* system for explorative language learning; Harbusch and Kempen, 2011) based on a *lexicalized, unification-based Performance Grammar* (Harbusch and Kempen, 2002; Kempen and Harbusch, 2002). The user assembles all constituents of a correct sentence interactively with the system, including revisions (cf. *scaffolded writing*). *EasyTalk* appropriately simplifies the decision dialogues with the generator. Moreover, the Per-

[11] We use the original term by Bell (1984) to refer to the wide area of how to enrich a text for making it understandable for the reader, i.e., taking a third-person perspective for understanding the text (reader-centered writing).

formance Grammar version we use is restricted to syntactic constructions of *Extended Leichte Sprache (ELS)*. ELS is a slight extension of LS. In LS, only easy words should be used. Abbreviations, genitive case, subjunctive mood, passive voice, and subordinate clauses are forbidden. Declarative main clauses should use the canonical SVO word order only. ELS covers constructions beyond the scope of pure LS that have been attested to be easy in experiments with LS readers (Bock, 2019). For instance, negation with *nicht* 'not' or passives with *werden* 'be' are licensed. The scope of constructions tested by Bock (2019) is extended with frequent constructions in LS text that are also frequent in spoken German (e.g., negation with $kein_{inflected}$ 'no', or simple past tense for auxiliaries and modals; cf. Harbusch and Steinmetz, 2022, for a corpus study into treebanks of LS text, spoken and written German to determine the range of constructions that the target group likely uses to articulate their thoughts).

The overall lexicon of *COMPASS* covers CELEX[12] (Gulikers et al., 1995). In *EasyTalk*, it is restricted to CEFR[13] L2-learner level A2. However, personalized entries or entries from specific contexts—like writing essays in school for a specific genre or topic—can easily be added.

To support low-literate users, all lemmas can be associated with symbols from the user's preferred set[14]. Moreover, the system provides a read-aloud function for all text elements.

Now, we cursorily highlight the supportive features during a typing session. A new sentence—thus, the overall session with *EasyTalk*—starts with a prefilled punctuation element (header = '.?!' and filler = '.') in the Sentence Panel (for details, see Steinmetz and Harbusch, 2021b). Elements in this panel and in the Next-Word Panel are always divided into a header and a filler.

Initially, the punctuation element is interactive. Clicking it changes the sentence type. By clicking repeatedly, it cycles through the different modes. Each choice sets up the ordered sentence constituents (e.g., verb-first for yes/no questions and imperatives) according to the ELS word order. The period as the default sentence type refers to a declarative main clause. If this option is selected, the header 'who' is displayed in the sentence-initial position. This header asks in easy words for the subject of the declarative main clause. Once the user has selected the first word form, the sentence type for the current sentence cannot be changed without backtracking, i.e., erasing all yet typed words—a precaution to avoid confusing word-order changes all over the yet typed sentence.

The upper snapshot of Figure 4, illustrates a later stage throughout typing. Now, cues referring to the grammatical functions for the overall sentence are displayed in the preferred ELS word order. If desired (e.g., a specific argument/attribute figures prominently in the user's mind), the user can select any header directly. Otherwise, the user follows the consecutive order provided by the system.

In addition to the advantage of offering the filling of the constituents in the order the user prefers, communicating the grammatical function of a word gives rise to presenting the suggestions for the word in its correct inflectional form—thus, speeding up typing. For instance, the finite verb is inflected according to the subject-verb agreement. Moreover, the system supports the correctly inflected typing of complex phrases filling any grammatical function position (like die_{ACC} $Katze_{ACC}$ *auf* dem_{DAT} $Dach_{DAT}$ *von* der_{DAT} $Nachbarin_{DAT}$ 'the cat on the roof of the neighbor'). In particular, all arguments are displayed as soon as the verb is known. *EasyTalk* checks whether obligatory arguments according to the verb valency are filled. The system refuses any instruction to finish the sentence before it is complete. The correct German word order for the entire sentence is yielded by the generator (cf. the sentence-final nonfinite verb in Figure 4)—another feature that reduces the user's mental load.

The word-by-word entering of sentences of the text takes place in the Next-Word Panel. It is subdivided into three components: (1) a text-input window at the top, (2) the pre-ordered header line in the middle controlling the content of (3) the suggestion list at the bottom. The user can type according to a personal strategy. The default prompting always highlights an active header in green (cf. F in an orange circle in the upper snapshot) and offers matching word forms in the suggestion list (with the correct inflectional ending in the current context). If desired, the user changes the currently active header. In Figure 4, we illus-

[12] CELEX is also available for Dutch and English. Thus, *EasyTalk* can be ported to these target languages with minor efforts.

[13] www.coe.int/en/web/common-european-framework-reference-languages

[14] By default, *EasyTalk* uses the ARASAAC symbol set: www.arasaac.org

trate the active choice of the header *Wie?* ‘How’. In turn, the system updates the suggestions for appropriate fillers. Words not visible in the suggestion list can be accessed by scrolling through the list (G), or by starting to type a word’s prefix (H)—given that the user knows the spelling. To select a word form, the user navigates to the desired list item and confirms the selection (I). Directly pressing 'Enter' quickly selects the topmost list item.

By the perpetual list of attribute headers, *EasyTalk* reminds the user to add cues that cannot be clarified as with face-to-face communication. In the upper snapshot of Figure 4, assumingly, the user has first typed all obligatory elements of the sentence. Due to the available headers in the Next-Word Panel, the user has activated the header *Wie?* ‘How’. (N.B. the header *Wen?* is still present for a potential extension of the most recently entered direct object *viele Hobbys*, for instance, by a prepositional object.) Accordingly, the suggestion list offers appropriate fillers. Typing the letter “n” in the text-input window shows the negation *nicht* ‘not’ as topmost item. Previous usability studies with different groups of L2 learners of German show that presenting attribute headers is stimulating to advanced users without disturbing tendencies for beginners (Harbusch and Steinmetz, 2022).

In addition, the Sentence Panel provides the meta-level commands to finish the sentence, or to erase the last word, respectively (cf. J and K in yellow spades in the upper snapshot). In order to avoid unintended operating errors, these elements are put far away from the typing keys. We expect the user to notice them when reading the finished sentence.

3.3 Sentence-combining support

On finishing a sentence, the middle area switches from the Sentence Panel to the Connector Panel.

Studies into an LS corpus with more than 29,000 sentences from a variety of LS text from the internet (Harbusch and Steinmetz, 2022) describe a problem. In order to provide text coherence, declarative main clauses deviate in 50 percent of the cases from the SVO order—although any deviation from SVO word order is very hard to understand by the target group (Bock, 2019). Moreover, the standard German writers of the LS text often resort to subordinate clauses—also forbidden in LS.

Es gibt zurzeit viel Corona in Deutschland.	‘There’s a lot of Corona in Germany at the moment.’
Darum	**‘Therefore’**
Ich kann viele Hobbys nicht machen.	‘I cannot do many hobbies.’
Und	**‘And’**
Es ist sehr langweilig.	‘It is very boring.’
Aber	**‘But’**
Ich habe eine Idee:	‘I have an idea:’
Ich schreibe jetzt eine Geschichte für meine Freunde.	‘I will write a story for my friends now.’

Figure 5: A short example text illustrating the impact to text coherence stimulating the use of connectors (in bold, red) in *EasyTalk*. The colon is a very frequent, yet ambiguous connector in LS. When selected, *EasyTalk* replaces the full stop with a colon instead of adding a separate line.

We suggest a very easy (E)LS-conform method to provide coherence cues. The idea is inspired by the German *weil*-V2 phenomenon in spoken German (the subordinating conjunction *because* is followed by a clause with main-clause V2-word order; cf. Reis, 2013 for a thorough survey). Based on audio and transliteration data from spoken German, Kempen and Harbusch (2016) argue that speakers start a new sentence after having uttered the conjunction. We reason that the concept of going on with a main clause after any conjunction or a sentential adverb in the Frontfield is a feasible generalization that circumvents subordinating clauses and focused elements in the Frontfield position in German without losing the information carried by these items. Looking at this claim from a sentence-planning perspective, any abstract relation known from the Rhetorical-Structure Theory becomes available as sentence connector between two main clauses. The resulting text reflects the writer’s conceptual message. Thus, the overall discourse structure, is conveyed much better than by choppy sequences of main clauses (cf. the text in Figure 5 with highlighted connectors preserving the constraints of (E)LS).

Via the Connector Panel (cf. Figure 4, lower snapshot), all abstract RST-relations are made accessible by using an intuitive wording from the target users’ vocabulary (e.g., REASON = *because*). The menu provides seven connectors—recommended by Netzwerk Leichte Sprache (2013)—for direct access (cf. the coordinating *and* (cf. L in a blue square) highlighted as active choice). Operating *Andere wählen* 'Choose other' (M) offers additional options in the Next-Word

Participant	P1	P2	P3	P4	P5	P6	P7	P8
Age	20-25	20-25	18-20	20-25	20-25	20-25	20-25	18-20
Gender	M	M	F	F	M	M	F	F
Condition(s)	ASD	ASD, VI	HoH, CCN	IDD	IDD, VI	IDD	IDD, MI	IDD, VI
Uses spelling checker	N	Y	N	Y	Y	Y	N	N
Uses a mouse	N	Y	N	N	N	N	Y	N
Regular computer use	N	N	N	N	N	Y	N	Y
Eye tracking recorded	Y	Y	Y	Y	Y	N	N	Y

Table 1: Data on the participants (Genders: M = Male, F= Female; Conditions: ASD = Autism Spectrum Disorder, VI = Visual impairments, HoH = Hard of Hearing, CCN = Complex Communication Needs, MI = Motor impairments, IDD = intellectual or developmental disorders). P8 opted out of the test on her own wish.

Panel. *EasyTalk* appends the selected connector at the end of the Text Panel. Initially, we leave the Next-Word Panel empty to avoid additional reading during the decision making for a connector. Choosing the arrow button (N) skips the selection of a connector. For details on the selection process, see Steinmetz and Harbusch, 2021b).

Now, we report the recent evaluation study.

4 Evaluation

In general, it is best practice to identify and correct usability flaws in software before it is made available to the user (see, e.g., Holzinger, 2005). For the target group, the first impression is particularly crucial for the acceptance of a system. AAC software is often abandoned after a short period of use (see, e.g., Dawe, 2006; Fager et al., 2006; Waller, 2019).

Maturing versions of *EasyTalk* were previously evaluated in several tests with substitute user groups (see, e.g., Steinmetz and Harbusch, 2020, 2021a) such as experts in the field of accessible communication and L2 learners (CEFR-level A1-B1 and differing computer skills). Nevertheless, it is essential to test the system with the actual target group (cf. Newell and Gregor, 2000; Henry, 2007; Nganji and Nggada, 2011, for user sensitive, inclusive design of accessible, disability-aware software). Here, we compare the previous findings with observations from the recent study.

4.1 Test setup and participants

Testing with people with disabilities presents unique challenges and increased organizational effort (cf. Lazar, 2017: Chapter 16, for an overview)—for example, special precautions currently need to be taken in direct contact with the target group which is particularly vulnerable to COVID-19 (cf. Rödler, 2020; Portal et al., 2021). Therefore, we conducted a qualitative case study aiming to uncover the biggest usability flaws in our software with only a handful of participants (cf. *discount testing*; Nielson, 1989).

For this purpose, we asked eight German-speaking participants, aged 18-25, with different conditions, writing and computer skills (cf. Table 1), to exploratively test the system in sessions from 25 to 40 minutes. The tests were performed under normal room lighting on a laptop with 15" display screen resolution of 1920x1080. *EasyTalk* had to be operated in the same setup (e.g., displaying the ARASAAC symbols) by all participants using the provided laptop keyboard and an external mouse.

4.2 Test procedure

Since predefined tasks—like in a usability study—might exert unnecessary pressure and frustration on the target group which could distract from evaluating the specific communication features in question we aimed to create casual situations in our experimental set-up that avoids unintentionally scrutinizing our participant's personal skills. To provide a feeling of security, the individual caregiver (or the writing workshop leader) and only one person from the evaluation team (the *interviewer*) were present during the sessions. Each session started with a brief warm-up to break the ice.

Standard evaluation techniques like thinking aloud or UX questionnaires[15] would overtax the target group. Complex, open-end questions are particularly difficult for participants with CCN or severe ASD. Thus, we abstained from systematically switching between typing and judging this process in a structured interview with post-task question as another potential source of irritation

[15] www.ueq-online.org/

due to test subjects feeling pressured to make a statement. Nevertheless, we encouraged the participants to give comments. As far as the participants complied, we elaborated on raised topics. Besides observing the participants as they typed their conceptual message and logging the users' actions, we decided to employ eye tracking as far as the participants gave their permission and conditions allowed for recording eye movements with a *Tobii Pro Nano*[16] to obtain objective information (cf. Bojko, 2005).

To explain how the system works, the interviewer wrote one sample sentence in *EasyTalk*: *Die Sonne scheint heute*. 'The sun shines today.'. The participants could opt for rehearsing the example interactively with the interviewer. Afterwards, all participants were invited to explore the system freely. (Before the experiment, the leader of the *Schreibwerkstatt* had advised participants with spontaneous decision-making problems to think up in advance the sentences they wanted to write during the experiment.) If needed, the participant received help with spelling or interacting with the computer either from the interviewer or the caretaker. At the end of the typing session, the interviewer exported the text from *EasyTalk* with or without symbols according to the participants preference to hand it to them as receipt for participating in the experiment. One final yes/no-question was asked to all participants: Would you like to use *EasyTalk* in the writing workshop in the future?

4.3 Results

In general, the evaluation corroborates the easy and intuitive interface design of *EasyTalk*. All participants successfully typed at least three sentences, with each sentence being an average of four words long with *EasyTalk* (see Figure 6 for the text typed in two sessions). Four participants spontaneously skipped the interactive example rehearsal and typed their own sentences without problems. Participant P8, who can write texts beyond the scope of LS in *MS Word*, stated that *EasyTalk* did not benefit her and opted out of the test after writing a four-word sentence. We exclude P8 in the following. Spontaneously, P5 judged: *"The headers help with concentration"* and *"The connectors between sentences are important. Sometimes there are longer sentences.*

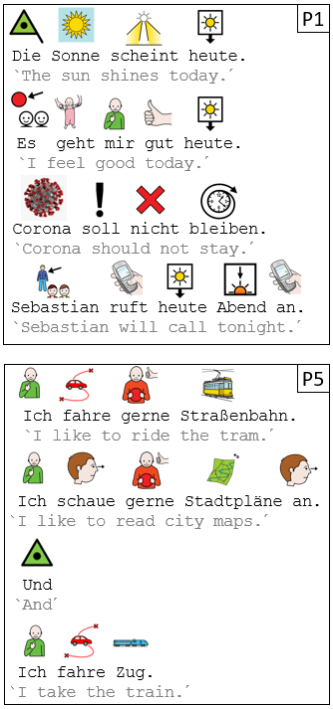

Figure 6: Two sample sessions. Top: Participant P1 chose to type the interviewer's example himself as first sentence. P1 skipped the choice of connectors all of the text; Bottom: P5 typed four sentences without rehearsing the interviewer's example and used an explicit connector once (*und* 'and').

You can do them piece by piece in this manner.". P2 stated: *"It works great but I have to concentrate a bit here."*. We attribute the overall positive result to improvements of the overall interface that were based on several evaluation rounds with substitute users. The current test confirms that the communication with the system is easy to learn due to intuitive dialogues all over the system.

The eye-tracking data supports this claim. We defined areas of interest (AOIs) in the interface to be able to track task-accomplishment paths. All users focused on the dialogue elements in the intended manner. With respect to effectiveness, we did not find traces of searching around for items. The eye-tracking data documents the inspection of the Text Panel after a sentence was finished.

One person spontaneously wrote a question. Participants P1–P7 supplemented their sentences with modifiers (e.g., *when?* or *how?* cues were spontaneously selected in the Next-Word Panel). Six participants completed the decision dialogue for complex verb constructions (Steinmetz and Harbusch, 2020). Although we had not demonstrated this decision dialog in the introduction, four participants typed verbs in present perfect tense, and two users selected a modal as finite

[16] www.tobiipro.com/product-listing/nano/

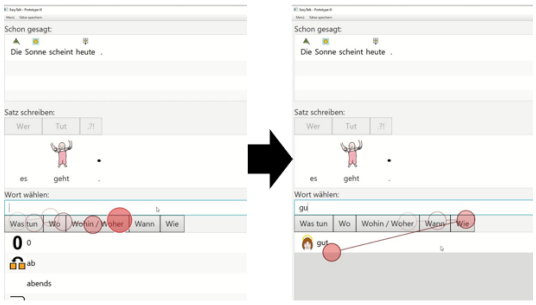

Figure 8: Two consecutive snapshots of P1 typing the third word of the second sentence. First, P1 focuses the headers in the Next-Word panel. In turn, P1 starts typing the word. Finally, P1 focuses the element *gut* 'good' in the suggestion list.

Figure 7: Gaze plot of P1while connecting sentences 2 and 3 using the Connector Panel. P1 looked at the previous text in the Text Panel and read through all connector options before operating the arrow button to skip the connector.

verb followed by an infinitive (cf. the example sentence in Figure 4). Two participants spontaneously erased words in the Sentence Panel using the red X-button—also not shown in the introduction. Clicking the green ✓-button in the Sentence Panel was shown, and completing a sentence was successfully performed by all participants. These observations also reflect that *EasyTalk* is easy and intuitive to use for the target group beyond explicitly demonstrated features.

With respect to efficiency, P4 systematically selected the words as soon as they appeared in the completion list in favor of writing the words to the end. In contrast, P6 initially typed every word from start to finish. Later on, P6 selected the words from the completion list as soon as possible. P2 commented: *"Writing to the end is better."* and judged the completion list as helpful to prevent spelling mistakes.

According to the eye-tracking data, the participants' focus while writing the current sentence was mainly on the Next-Word Panel. The Text Panel and the Sentence Panel were used to back up the flow of thoughts. In detail, the participants exhibited different interaction strategies (Figure 8, e.g., illustrates P1's word selection strategy of focusing the wh-cues). To connect a sentence, all participants looked at the previous text in the Text Panel and read through the Connector Panel (see Figure 7 for an example gaze plot). However, the eye-tracking data unveiled shortcomings of the Connector Panel's layout. Often, the second row of connector options was considerably less likely inspected. Unfortunately, nobody felt inclined to add a connector systematically after reading through all/some options. Accordingly, we plan to shorten the list of mentioned options. Moreover, we intend to set up an active training mode in *EasyTalk* that teaches when and how to use text connectors (Reid et al., 2013).

Because of the participants' overall positive response to the question of whether they wanted to use the system, the leader of the writing workshop asked for a copy of EasyTalk for using it in future.

5 Conclusions

We presented *EasyTalk*, an intuitive-to-use writing assistant for fast and correct text writing in ELS for low-literate users with IDD and/or CCN. The evaluation verified the claim that users can instantaneously type complete and correct sentences with *EasyTalk*. However, the offer of connectors should be improved. As mentioned above, we plan a make-over of the Connector Panel combined with an active teaching unit. It is an open question to which extent automatic storytelling concepts (cf. Section 2.3) can be incorporated into the active training mode of our system (cf. Steinmetz and Harbusch, 2021a). We intend to evaluate this new feature in longitudinal studies with the target user group.

Besides further above-mentioned future work, personalized features for specific user groups will be realized. Moreover, a native smartphone version is under development.

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