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ARTICLE

Google Translate as a Tool for Self-Directed Language Learning

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Abstract

This study examined the pedagogical use of Google Translate (GT) and its associated text-to-speech synthesis (TTS) and automatic speech recognition (ASR) as tools to assist in the learning of second/foreign language Dutch vocabulary and pronunciation in an autonomous, self-directed learning setting. Thirty participants used GT (its translation, TTS, and ASR functions) for one hour to learn a set of phrases and their respective pronunciations in Dutch (e.g., "I don't understand" Ik begrijp het niet [ɪk bə'grɪp ət nit]). The study followed a pre/post/delayed posttest design that examined the participants' learning of phrases and their pronunciations in Dutch, combined with a qualitative analysis of video recordings of their interactions with GT. Findings indicate that the participants were able to acquire Dutch vocabulary and pronunciation on a short-term basis, and that they interacted with GT's translation, TTS, and ASR in different ways and to different extents. This demonstrates that GT is a versatile tool that can be easily tailored to suit learners' needs, interests, and learning styles.

Keywords: *Google Translate, TTS, ASR, Self-Direct Learning*

Language(s) Learned in This Study: *Dutch*

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Introduction

People who want to learn a new language are constrained by myriad impeding factors that include the lack of access to courses, busy schedules, and prohibitive cost (Roediger & Pyc, 2012). Although language learning tools are being developed regularly to circumscribe these constraints (e.g., Duolingo, Memrise), lesser-learned languages such as Dutch remain overlooked (Godwin-Jones, 2013). As some of these tools might not be as efficient in communicating aspects of a foreign language as others, it is important for researchers, teachers, and students to be aware of the affordances of popular language learning tools (Neri et al., 2002). This could potentially help learners in a self-directed language-learning context to become more efficient with their time and more successful in their learning endeavours.

There are three main features that shape the definition of a self-directed learner (Zimmerman, 1990): their self-motivation, their use of autonomous learning strategies, and their ability to assess the effectiveness of these strategies through self-evaluated feedback (note that Zimmerman uses the term "self-regulated"; however "self-directed" and "self-regulated" are commonly used interchangeably; e.g., Abar & Loken, 2010). These three features simultaneously summarize what autonomous learners must do to be successful (Zimmerman, 1990). Consequently, as instructors, we should deliberately utilize technologies that can be used autonomously so that learners can increase their motivation to learn, develop learning strategies, and learn how to benefit from the feedback provided. From a student's perspective, the self-directed learner must perceive the use of technology positively and, more importantly, match it with their learning

expectations (Lai, 2013).

One tool that can fulfill the requirements for self-direct learning is Google Translate (GT), a non-pedagogical resource that is generally used for automatic translation purposes. However, it has many useful functions that have not been explored in a comprehensive way, including text-to-speech synthesis (TTS) and automatic-speech-recognition (ASR). This study is an investigation into the feasibility of using Google Translate in a self-directed language-learning context, emphasizing the tool's abilities to motivate learning, help students develop their autonomous learning strategies, and understand the types of feedback afforded by the technology. In this environment, the language-learning context is not centered in a classroom nor fully directed by a teacher; instead, it is in a context of self-directed learning.

Background

Self-Directed Learning

In a self-directed learning (SDL) context, the learner is in charge of their own learning, as opposed to in a classroom setting where both the teacher and student are involved (Little, 1995). In this context, learners have the added responsibilities of keeping themselves accountable and making sure that they progress. Du (2013) argues that self-directed learning encourages motivation, critical thinking, self-evaluation skills, and instils interest in life-long learning (necessary in a global economy and information-centered society). This means that it is important that we are able to both self-teach and have the skills to do so effectively in order to succeed in life. According to Sert and Boynuegri (2017), a critical component of life-long learning is self-directed learning, which can be enhanced by technology. Interestingly, this idea coincides with one of Chapelle's (2001) criteria for selecting computer-aided instruction: strategy development, a criterion that refers to the likelihood that a technological tool will continue to be used by the participants (e.g., for language learning or their own personal development), beyond the confines of the research environment. This paper intends to examine one of these tools, which we believe has great potential to promote life-long learning and strategy development: Google Translate.

In a CALL context, learner autonomy (a component of SDL) can be defined as the learner's ability to know what is needed in terms of language learning, and their ability to accomplish these goals with the help of technology (Chik, 2018). Another important factor is motivation (Godwin-Jones, 2019). Zimmerman (2000) makes a connection between self-regulated learning and motivation. He claims that a learner's self-efficacy belief can act as the driving force to motivate their learning, discovering that highly self-efficacious and motivated learners, in a self-regulated context, produce higher academic achievements (Zimmerman, 2000). Therefore, the key is that learners must be able to follow the process of knowing what is needed, be motivated to act on that knowledge, and use technology to achieve it.

Self-Directed Language Learning

In the context of second/foreign language (L2) education, research on self-directed language learning is scarce, and it has mostly been done simultaneously as part of a language course. Accordingly, the research has often looked at the student's work outside of class time (Bahri & Mahadi, 2016; LaRocca et al., 1999) and, for this reason, cannot be classified as truly autonomous. However, these studies have a lot to offer in terms of knowledge on learner behaviour. One of the most common findings among this research is the learners' need for motivation (Mutlu & Eroz-Tuga, 2013). When perceived motivation is high, learners are more likely to engage in language-enhancing activities, particularly outside of the learning environment.

Another factor that impacts autonomous learning and which interacts with motivation is direction: when learners are given explicit directions to follow, their motivation increases, potentially resulting in learning (Mutlu & Eroz-Tuga, 2013).

Self-Directed vs. Self-Regulated: What's in a Name?

We use the term "self-directed" instead of "self-regulated" learning. Although the literature often refers to

the two constructs as semantically the same as they both involve active, controlled, and goal-directed behaviour, we adopt the term "self-directed" for convenience and because it is the most frequently used in the field of adult education (Cosnefroy & Carré, 2014).

Google Translate and Language Learning

Technology has significantly altered the way we live and has created more opportunities for autonomous language learning (Godwin-Jones, 2019). In our study, we focus on one of these technologies, Google Translate (see forthcoming description of this tool and how it has been utilized in CALL research). To better examine the effects of Google Translate in SDL and compare learning among participants (it would be difficult to compare gains in vocabulary and pronunciation without isolating the technology and limiting the target learning elements), we have created a more controlled learning environment: a semi-self-directed learning setting. As such, it constitutes a mixture of purely self-directed learning, in which learners are in charge of all learning, and teacher-based instruction, where the teacher is in charge of some of the learning decisions. We refer to this as a "Teacher-Structured Self-Directed" learning environment, displayed in Table 1, where we illustrate the responsibilities of teachers and learners across four learning components: objectives, learning tools, learning strategies, and time on task. For Teacher-Structured Self-Directed Learning, the objectives and the learning tools are provided (so that we can control the target tool and learning outcomes), but students (as self-directed learners) are given the freedom to discover their own learning strategies and manage their own time to learn, similarly to how they would experience these learning components in pure SDL.

Table 1

Teacher-Structured Self-Directed Learning

Learning Components	Self-Directed Learning	Teacher-Based Learning	Teacher-Structured Self-Directed Learning
Objectives	Learner	Teacher	Teacher
Learning Tools	Learner	Teacher	Teacher
Learning Strategies	Learner	Teacher	Learner
Time on task	Learner	Teacher	Learner

To determine its feasibility in an autonomous learning context, we examined the following two language features of Dutch: vocabulary and pronunciation.

Vocabulary

According to Nation (2003), vocabulary teaching should be tackled by a four-pronged approach: learning through meaning-focused input, meaning-focused output, deliberate learning (i.e., focus on form), and fluency development. While meaning-focused input targets listening and reading practice, meaning-focused output encourages students to concentrate on communicating through speaking and writing. Based on Nation's recommendation, this study includes learning that emphasizes meaning-focused input (e.g., translating and listening to Dutch using GT's TTS), meaning-focused output (e.g., speaking/repeating a recently-learned phrase via ASR) and deliberate learning (e.g., taking notes on how words/phrases are spelled and pronounced), thereby addressing three items in Nation's approach to vocabulary instruction.

The literature has some evidence that the use of technology can assist in vocabulary learning. Liu and Lin (2016), for example, compared the affordances of computerized versus manual dictionaries and found that vocabulary-learning was significantly higher when participants used an electronic pop-up dictionary in comparison with looking up a word in a dictionary. Through this technology-enhanced method, students encountered more new words and consequently had more opportunities to acquire them. Based on these optimistic findings, in the current study, participants used Google Translate, a tool that has the potential to

offer abundant opportunities for learners to encounter (and consequently learn) new words and phrases.

Pronunciation: Input, Output and Feedback

To know a word in an L2 includes much more than understanding its meaning. According to Nation (2003), this knowledge also includes knowing how the word is pronounced. To evaluate how this component of word knowledge is used in CALL, Neri et al. (2002) conducted a comprehensive analysis of multiple programs according to three pedagogical requirements for pronunciation: access to vast amount of input to contextualize the learning objectives, multiple opportunities to practice output, and feedback capabilities. In a number of studies, immediate feedback was considered to be the most effective form of feedback for listening comprehension and oral activities (Shu-Ping et al., 2012). Accordingly, in the current study, we adopt ASR and TTS, which offer students immediate feedback via orthography (provided implicitly, as will be discussed later). However, we acknowledge that in the context of GT and its speech-related capabilities, the immediate feedback remains limited, as the participants must learn to interpret the orthography as feedback.

An important aspect in pronunciation studies is to determine how its acquisition can be measured and assessed. According to Derwing and Munro (2009), there are three measures to assess learners' pronunciation: intelligibility, comprehensibility, and accentedness. Intelligibility is defined as "the degree of a listener's actual comprehension of an utterance" (p. 478), while comprehensibility is "the listener's perception of how easy or difficult it is to understand a given speech sample" (p. 479). Finally, accentedness is often defined as "the way in which speech differs from the local variety of [that speech]" (p. 476). Adopting a similar holistic approach to assess pronunciation, these measures allow us to investigate to what degree Google Translate and its TTS and ASR features impact the pronunciation of L2 Dutch learners in an SDL setting.

Text-to-Speech: Access to Increased and Enhanced Input

TTS software reads written text out loud, thus allowing learners to receive input that can be enhanced in terms of quantity and quality (see Liakin et al., 2017a for details). According to Nation (2003), access to increased and enriched input is often an issue in L2 (particularly *foreign*) learning contexts, and even more so for lesser-taught languages such as Dutch (the target language for this study), especially when native or fluent speakers are not accessible.

According to Chapelle (2003), input enhancement techniques such as repetition are key to L2 learning. In the context of vocabulary, it has been reported that students need to review or be exposed to the target words between two to ten times to successfully recall them (Yeh, 2014). TTS affords learners with an unlimited amount of access to the input and ample opportunities for repetition/practice. For pronunciation, we are not aware of any research on the amount of aural input and repetition necessary for successful learning.

Arguments have been made that TTS is not ready for use in language learning, particularly because of its limitations in terms of accuracy and naturalness (Handley, 2009). However, more recent studies confirm that, due to recent advances in speech synthesis, TTS is suitable as an L2 model for pronunciation learning at least for English pronunciation (Bione & Cardoso, 2020). This is especially true in foreign language contexts where access to the L2 is limited.

Automatic Speech Recognition: Opportunities for Output and Feedback

ASR converts natural speech into text. From an L2 perspective, research suggests that learners are willing to use the technology for oral practice because they seldom have enough opportunities for speaking practice (output; LaRocca et al., 1999). These opportunities for practice create multiple opportunities for learners to receive and, we hypothesize, interpret feedback. Many studies emphasize the importance of feedback provided to students through ASR, as it can empower them to learn autonomously (LaRocca et al., 1999; Liakin et al., 2017b).

Not only does ASR create additional opportunities to practice autonomously and provide learners with the chance to receive feedback (e.g., via a comparison of the ASR transcriptions of their oral attempt with their intentions), it also positively affects their learning outcomes in pronunciation. In Liakin et al. (2014), for instance, participants who used ASR to learn the French vowel /y/ outperformed those in a control group. Students also recognize the pedagogical value of ASR, as they believe its use improves their pronunciation performance (Liakin et al., 2014), boosts their motivation (LaRocca et al., 1999), and increases their overall enjoyment in the classroom (Chiu et al., 2007). Since learners perceive ASR as useful and enjoyable, it is possible to conjecture that these traits will motivate them to use the tool more regularly. We interpret these traits as instantiations of motivation, as if learners perceive the tool as useful and enjoyable, that might trigger an increase in motivation to learn.

In a study focused on learners' perceptions of TTS and ASR, Liakin et al. (2017b) analyzed their data based on Dickerson's (2015) model for pronunciation teaching. This model suggests that the development of prediction skills (using orthography) can lead to improvements in perception (via TTS) and oral production (via ASR). Prediction is assumed to be the result of the establishment of grapheme-to-phoneme rules (e.g., that orthographic "ea" is pronounced /i/ in English), obtained through exposure to input (TTS) and oral practice (ASR). The researchers investigated learners' perception of these technologies in an autonomous environment in which French students learned how to perceive and produce French /y/ autonomously. They found that learners met many of the criteria set for effective L2 learning (e.g., multiple chances for output practice and building prediction skills), suggesting that TTS and ASR may be suitable for use in a self-directed learning context. The present study adopts Dickerson's (2015) view by combining translation, TTS and ASR and applying it to self-directed L2 learning.

It is important to emphasize that teachers and learners should rely on the tools that are most practical and that address their learning needs and goals (Yoshida, 2018). This highlights the importance of TTS and ASR: they are practical and relevant to the self-directed learning context and specifically address vocabulary building and pronunciation. What if the two technologies were combined and used in a self-directed learning setting? This scenario can be created using Google Translate.

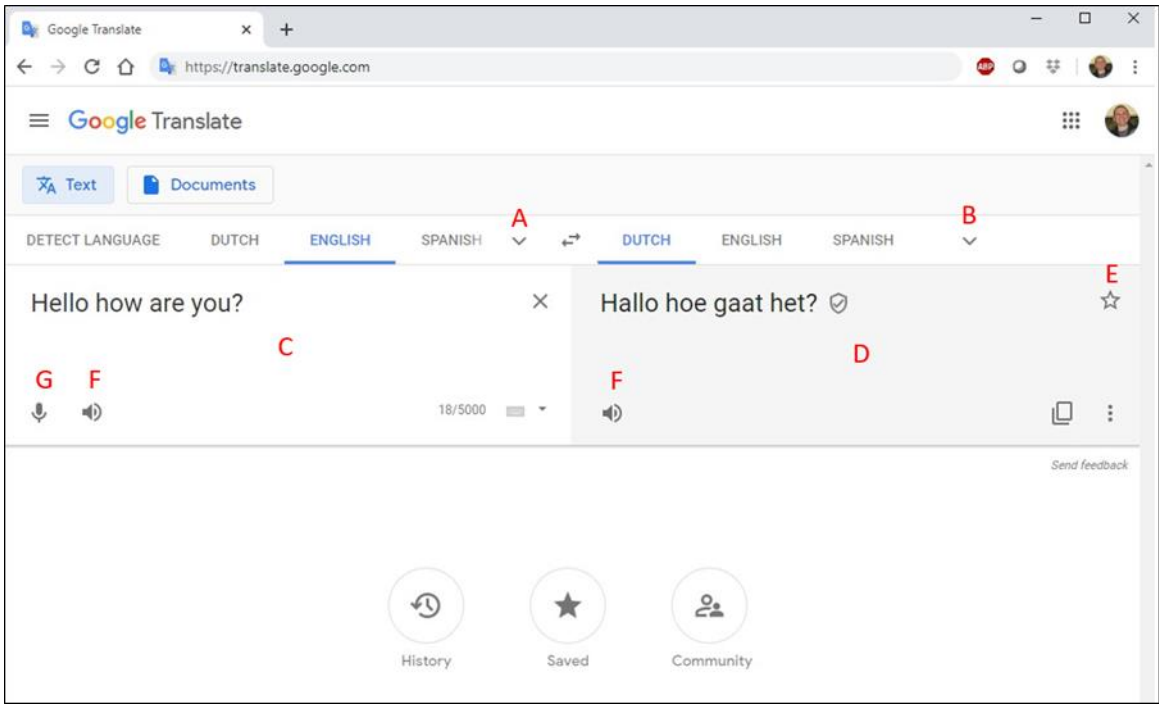
Google Translate

Google Translate is an instant translation tool that can be accessed via a web browser or a software application. Using both TTS and ASR, it can translate words, phrases and full texts from one language to another. As illustrated in Figure 1, on the left side of their screen, GT users can choose their desired language in the textbox by pressing the drop-down arrow (A). Next, they will move to the right side of their screen and choose the language of translation, again using the drop-down menu (B). Once the user has entered the text they wish to have translated in the left textbox (C), GT makes an instant translation (D). The tool also features a phrasebook option, which automatically saves the translation in a glossary when users press the star icon above the translated text (E).

GT uses TTS technology to read the original or translated text out loud. Users can use the TTS function by clicking on the speaker icons that appear in both the original and translated textboxes (F). ASR is activated by pressing the microphone icon in the left textbox (G). The message then immediately appears in the textbox (C) and is translated.

Figure 1

Features of Google Translate



We are not aware of any empirical studies that examine the quality and authenticity of GT's speech output and recognition. However, Bione and Cardoso (2020) evaluated a popular TTS-generated voice in terms of its speech quality, ability to be understood by L2 users, and potential for focus on specific language forms. They concluded that TTS systems have the potential to be used as pedagogical tools for L2 learning, particularly in English as a *foreign* language settings, "where natural occurrence of the target language is limited or non-existent" (p. 169). This generalization applies to the proposed GT-assisted SDL learning environment, in which natural occurrence of the target language is non-existent.

Studies using GT as a translator abound in the literature, with the majority suggesting that it is a helpful tool, particularly because it is easily accessible and free (e.g., Leite et al., 2016). Although some recognize that GT provides intelligible and acceptable translations (Groves & Mundt, 2014), others caution against its use because its output is not often accurate (Pollitt, 2014). Another important factor to consider when using GT as a translator is the input and output language selection. Some languages, such as English, are far more developed on GT than lesser-known languages. Therefore, the accuracy and intelligibility of the output may vary from language to language.

Google Translate has also been used in schools. In Malaysia, for instance, Bahri and Mahadi (2016) examined how international students learn aspects of Malay using GT as a supplementary pedagogical tool. They discovered that GT was effective for vocabulary learning and the improvement of writing and reading. Interestingly, the authors concluded that students could benefit from GT in a self-directed learning environment if they were equipped with the appropriate knowledge to use it effectively. Building on this idea, the authors suggest that using GT in classroom activities could encourage learners to study independently and allow them to create their own strategies to work out language learning problems. Some of these suggestions influenced the design of the current study.

The Study

Google Translate's ability to assist language learners in vocabulary and pronunciation learning needs to be

explored for at least two reasons. Firstly, there has been a lack of research combining translation, TTS, ASR as learning tools; this would extend Dickerson proposal to a CALL context (i.e., one that emphasizes perceiving, producing, and predicting pronunciation patterns). Secondly, GT seems to be an optimal tool to address these gaps in the literature, as it meets most of the criteria set by Chapelle (2001) to endorse computer-assisted language learning: it is flexible (e.g., it can be adapted to one's learning style), it has potential to promote learning via increased and enhanced input and output practice (i.e., it has language learning potential), it has the ability to provide feedback (via the orthographic output of ASR), it encourages human-machine interactions which can have a positive impact on learners' autonomy and general well-being (positive impact), and it allows for strategy development (e.g., students learn the skills to learn Dutch via GT but they might continue to use it to learn about other languages).

To investigate different aspects of the feasibility and potential of using Google Translate as a pedagogical tool in a self-directed language learning (SDLL) context, the following research questions were explored:

1. To what extent can learners acquire Dutch phrases and their pronunciations after using Google Translate in a SDLL environment?
2. How do learners interact with Google Translate to learn an L2?

Based on the literature of SDLL (e.g., Little, 1995), it was hypothesized that participants would develop a basic level of lexical knowledge and become intelligible and comprehensible in orally producing the learned lexical items using GT. Building on the research on individual differences (e.g., Dörnyei, 2005), we also predicted that the participants would discover individual ways to interact and learn from (and with) the technology.

Methods

Participants: Dutch Learners and Raters

Thirty adults participated in the study (9 males, 21 females; Age: 18-35). They came from various language families (e.g., English, Kannada, Arabic, from a total of 13 languages) and educational backgrounds, and had no previous knowledge of Dutch, nor were they familiar with German or Scandinavian languages. Participants' use of Google Translate prior to the study was reported, on average, as 3.8 out of 6 (where /6 constitutes the highest level of use) with a standard deviation (SD) of 1.4. They used GT mostly for translations and were not aware of its speech capabilities. On average, participants rated the phrase "I enjoy working with technology" 4.9/6 (SD = 1.0), and the question "How interested are you in learning new languages?" 5/6 (SD = 1.0). Eight of the thirty participants reported that they had tried to learn a language on their own before using tools such as grammar books and Duolingo.

The raters were three Dutch native speakers with no previous experience in this type of research. They were two males (both with degrees in trades), and one university-educated female. They all speak English as an L2 and currently live in Canada.

Materials: Objectives List

During the experiment, the participants were provided with a list of 10 learning "objectives" that they should accomplish within the allotted 60 minutes (see Appendix A). These objectives (e.g., learn how to say "hello" in Dutch) were selected by the researchers and provided in English. The objectives were selected based on their usefulness in real-world scenarios and their status as beginner-level phrases (Thering, 2018). Since our participants had no prior knowledge of Dutch, we did not include complex structures to avoid issues associated with items that follow "developmental sequences" (see Pienemann, 2007).

The last objective ("Choose your own phrase to learn in Dutch") was chosen to allow the participants the freedom of choosing and learning their own expression. This also gave us a unique utterance for the assessment of intelligibility (a transcription task), as we cannot utilize any of the other utterances since the raters will already be familiar with the nine learning objectives, therefore delegitimizing the transcription

task. Some of the phrases selected by the participants included "Good morning" and "I am a student." GT was able to accurately translate these phrases from English to Dutch.

Instruments

Questionnaire

A demographic questionnaire was used to collect the participants' background information, including the languages they speak, whether they had learned a language in a self-directed manner, if they had used GT previously, and their educational background (Appendix B).

Tests: Pronunciation and Vocabulary

A pretest was used to ensure that the participants had no previous knowledge of Dutch; it asked participants to produce orally the target 10 learning objectives. The same test was then used for the immediate and delayed posttests.

Procedure

Participants were asked to sign an informed consent form and fill out a demographic questionnaire before engaging in the study. They first completed the pretest, which was audio-recorded, and were then given a 5-minute tutorial on how GT works (e.g., how to translate a phrase, listen to it in TTS, and test their pronunciation using ASR). The participants were then provided with the objectives list and given one hour to complete the assigned goals. As instructed (but also attested in audio and video recordings), all participants translated from English to Dutch. The participants were video-recorded by a camera on a tripod throughout the experiment.

At the end of the experiment, the posttest was administered, in which the participants were asked to produce orally the target Dutch phrases presented to them in random order, which was audio-recorded. They were then asked to participate in a semi-structured audio-recorded interview with the main researcher so that they could provide an account of their learning experience (these findings will be reported in a separate article). Finally, approximately two weeks after the initial research was completed, a delayed posttest was performed, consisting of procedures similar to the ones described for the posttest. Participants were asked to not practice the phrases they learned or engage in any Dutch language learning between the posttest and delayed posttest.

Data Analysis

Questionnaire

The questionnaire was used to support and further develop the data found via the tests and recordings.

Tests: Pronunciation and Vocabulary

The pretests were analyzed using descriptive statistics (via the computation of means and standard deviations) to ensure that the participants were suitable candidates. Following Derwing and Munro's (2009) approach to assessing L2 pronunciation holistically, three Dutch native speakers (raters) transcribed and rated the posttest audio to analyze intelligibility (how much was actually understood by the raters, via the transcription of the personalized, unique phrase in the learning "objectives"), comprehensibility (how much the raters believed they could understand the participant), and accentedness (how accented the target speech was). Comprehensibility and accentedness were rated on a 1-6 scale, where 1 meant "incomprehensible" or "very accented" and 6 "completely comprehensible" or "not accented at all" respectively.

The same three raters transcribed the last participant-selected objective. The transcribed phrases were rated 1 when wrong, 3.5 when partially correct, and 6 when correct (these 1-6 values were selected to comply with the scale used for the other pronunciation measures). The scores from the raters were then analysed statistically (means and standard deviations or t-tests to determine pre-posttest improvements). The same procedures were used to compute the delayed posttest results.

Vocabulary learning on the two posttests was determined by two judges who independently rated each utterance using a 0-1 scale: 0 was used for fully incorrect phrases (or no answer), 0.5 for partially correct, and 1 for correct. The results for pronunciation and vocabulary development were used to answer research question 1.

Video-Recordings

Video-recordings of the participants' experiences were watched, described and analyzed for the different strategies that they used to achieve the objectives: to learn a set of phrases and their pronunciations in Dutch using GT. The analysis was guided by the following questions: How many times did the participants listen to the TTS? How many times did they repeat after they heard the synthesized voice? How often did they use the ASR? How many times did they practice the phrase without using TTS or ASR? If the participants created their own learning strategy, what was it? This data was used to answer research question 2.

Results

Research Question 1

To determine vocabulary learning, the Dutch phrases that were learned and recalled on the tests were calculated by two raters using 0 for incorrect, 0.5 for partially correct, and 1 for correct, for each target item. The inter-rater reliability among these raters was calculated using intraclass correlation procedure: ICC(2, 2) = .98 for the posttest, and ICC(2, 2) = .98 for the delayed posttest. For problematic cases, raters discussed and agreed on each of the discrepancies (32 items from 600 tokens; 5.33%) and arrived at a consensus.

Each participant had zero knowledge of the target phrases at the pretest and so there was no need for a pretest-posttest comparison, as the gains in vocabulary knowledge were robust, going from no knowledge (0/10) to almost full acquisition of the ten target items (9.5/10). However, from posttest (M = 9.5/10, SD = 1.5) to delayed posttest (DPT) (M = 5.4/10, SD = 4.5), t-test results showed that there was a significant decrease in the amount of vocabulary retained, $t(29) = 14.54$, $p = .001$. A summary of the results is shown in Table 2.

Table 2

Vocabulary Gains: Mean Scores

Measures	Pretest /10	SD	Posttest /10	SD	DPT /10	SD
Phrases learned	0	N/A	9.5	0.3	5.4	0.9

Our findings suggest that L2 learners can successfully acquire vocabulary (and related pronunciation) when learning Dutch as a foreign language using Google Translate. Although this robust improvement was not sustained over the delayed posttest, 54% of the target phrases were retained.

Pronunciation was only measured for the posttest because the delayed posttest was affected by vocabulary loss (as mentioned above), consequently affecting the raters' ability to assess the participants' pronunciation at that stage. In addition, the raters already knew the target phrases and vocabulary used in the immediate posttest, consequently biasing their judgments at a later pronunciation assessment. As seen in Table 3, there was substantial improvement in all three pronunciation components (comprehensibility, accentedness and intelligibility) from pretest to posttest as participants had no initial knowledge of Dutch pronunciation. Consequently, t-tests were not appropriate to measure the improvements observed. These results suggest that, considering the speech data collected immediately after the treatment of the 10 target phases, the Dutch-learning participants became orally comprehensible (4.2/6), had little foreign accent (5/6) and were deemed intelligible (5.2/6) by the three raters.

Table 3

Learner Pronunciation: Mean Scores

Measures	Pretest /6	SD	Posttest /6	SD
Comprehensibility	0	N/A	4.2	1.1
Accentedness	0	N/A	5.0	1.2
Intelligibility	0	N/A	5.2	1.2

Research Question 2

To answer this question, video data of the learners' interactions with Google Translate were analyzed. Ten different kinds of interactions with the technology, referred to as "learning strategies", were observed. For each participant, the number of times they listened to the TTS, repeated after the TTS, used the ASR, and practiced without either technology (No Prompt Practice) was recorded. The general patterns generated ten strategies, which are summarized in Table 4. For example, the eight participants in TTS-RP-ASR listened to the TTS 121.4 times (*SD* = 57.2), repeated (RP) after the TTS 67.1 times (*SD* = 41.8), used the ASR 120 times (*SD* = 30.9), and finally engaged in No Prompt Practice 121.4 times (*SD* = 43). The No Prompt Practice is defined as a repetition of the target phrase by the participant, without the use of TTS and ASR. It should be noted that these were the participants' dominant learning strategies, as they also borrowed actions from the other strategies as well as used non-technology related approaches. For instance, while most participants used paper to varying extents (e.g., to write words and their pronunciations), one chose not to use any paper to help them learn the words. Interestingly, two participants used a chanting method in which they orally repeated the target word or phrase several times to memorise them.

Sixteen participants were categorized into two different learning strategies, containing eight participants each. In the first most commonly-used strategy, participants listened to the TTS, repeated after they heard the synthesized voice (RP), and then proceeded to try the ASR (TTS-RP-ASR). The participants in the second most commonly-selected strategy listened to the TTS and immediately afterwards tried the ASR (TTS-ASR), without orally imitating/repeating the TTS voice.

Twelve participants were sorted according to six different learning strategies, each containing two participants. The first pair of participants used a strategy similar to the TTS-ASR approach but added self-practice (SP; e.g., repeated the target phrase to themselves), using neither the TTS nor the ASR to self-assess their attempt (TTS-ASR-SP). The next pair used a TTS, repetition, and self-practice approach; minimal ASR was used (TTS-RP-SP). The participants using the ½ TTS ½ ASR strategy split their time initially only engaging the TTS and then abandoning it to work with the ASR. Two further participants attempted to predict the pronunciation (Pr) of the word or phrase before they listened to the TTS. They then repeated after the TTS and attempted the ASR (Pr-TTS-RP-ASR). The next two participants split up each phrase and used the TTS for each individual word (W), then repeated and tried the ASR function (TTS(W)-RP-ASR). The subsequent pair of participants worked in silence writing down the translation of each word, then later listened to the TTS and attempted to pronounce it using the ASR (WR-TTS-ASR). The remaining two participants used unique strategies that were not used by any other participant. These strategies included: to listen to and repeat after the TTS for the first half of the session and attempt pronunciation with the ASR during the last half, or to type in all phrases while speaking simultaneously with the TTS (TTS-(S)RP), accompanied by ASR practice.

Table 4

Learner Strategies While Interacting with Google Translate

		TTS Listens	TTS Repeats	ASR Use	No Prompt Practice
Learning Strategy	***n***	***M/SD***	***M/SD***	***M/SD***	***M/SD***
TTS-RP-ASR	8	121.4/57.2	67.1/41.8	120/30.9	121.4/43
TTS-ASR	8	86.4/25.3	8.8/8.7	124.9/55.8	15.4/28
TTS-ASR-SP	2	72.5/6.4	11.5/7.8	70.5/36.1	268/130.1
TTS-RP-SP	2	105/8.5	60/2.8	18.5/2.1	261.5/37.5
½TTS-½ASR	2	99.5/16.3	1/1.4	135.5/58.7	13.5/19.1
Pr-TTS-RP-ASR	2	104.5/12.0	74.5/19.1	89.5/50.2	303/141.4
TTS(W)-RP-ASR	2	117.5/78.5	55/65.1	49/21.2	21/28.3
WR-TTS-ASR	2	60/11.3	0.5/0.7	151/46.7	8/11.6
½TTS-RP-½ASR	1	119/-	79/-	70/-	112/-
TTS-(S)RP-ASR	1	123/-	51/-	44/-	113/-

Note. Mean and Standard Deviation are calculated from the total amount of times each participant engaged in the action. The acronyms used are: TTS (text-to-speech), ASR (Automatic speech recognition), RP (repeated practice), SP (self-practice), ½ TTS (half time on TTS, alternating between the two technologies), ½ ASR (half time on ASR, alternating between the two technologies), TTS(W) (TTS used for individual words), Pr (predicted pronunciation, without TTS assistance), WR (writing, taking notes), TTS-(S)RP (simultaneous repetition with the TTS output).

These results indicate that the participants used a variety of strategies to learn with Google Translate, but seemed to prefer TTS-RP-ASR and TTS-ASR.

Discussion

Below, we provide a discussion of the main findings regarding GT's ability to promote the learning of L2 Dutch phrases and associated pronunciations, as well as the learning strategies they utilized during its use.

Vocabulary and Pronunciation Learning

There was a substantial learning gain in vocabulary as participants scored an average of 9.5/10 on the immediate posttest. This score was accompanied by a strong inter-rater reliability rating, which informed us that the raters had little difficulty in assessing the participants' speech, thus increasing the reliability of the results. Our findings show that Google Translate, in combination with its two speech technologies, has the ability to be an effective learning tool, at least in terms of "short term learning." Unfortunately, there is not much literature to attest to the hypothesis that both TTS and ASR are effective tools for short-term vocabulary learning, but the CALL literature indicates that when the pedagogical intervention is brief, as was the case in the current study, some of the learning is ephemeral (e.g., Roediger & Pyc, 2012; see also Chukharev-Hudilainen & Klepikova, 2017 for evidence that repetition over a sustained period may increase learners' long-term vocabulary retention).

From posttest to delayed posttest, there was a significant decline in vocabulary retention. It is important to note, however, that participants were still able to recall, on average, over 50% (5.4/10) of the target Dutch phrases two weeks after their one-hour (and only) GT-based learning session, without any further practice. To examine the lasting learning effects of GT, the participants were asked not to engage in any GT-based practice until they completed the delayed posttest. This decrease can be explained by the fact that the study

does not necessarily reflect a standard learning context, in which learners would probably be encouraged to study and practice the target forms, store them in long-term memory, and eventually master them. With the inclusion of sustained practice and spaced repetition, as proposed by Roediger and Pyc (2012), GT could become a more effective tool for long-term learning. Spaced repetition, a method in which participants review previously learned material with increasing intervals of time, has been shown to enhance retention of information even years later (Ullman & Lovelett, 2016). Similarly, it has been demonstrated that with only three minutes of technology-stimulated vocabulary activities a day, learners can increase their vocabulary retention (Chukharev-Hudilainen & Klepikova, 2016). Future studies on the use of GT could incorporate spaced repetition into their research and investigate the tool's long-term effectiveness. This would also provide an opportunity to further examine the retention of pronunciation patterns at the delayed posttest, which we were not able to assess due to the loss of vocabulary, as mentioned earlier.

The delayed posttest vocabulary scores not only showed us the long-term effect of GT, but it also revealed some individual differences between participants, reinforced by the high standard deviations observed for vocabulary retention. Some participants were able to remember up to 80% of the target phrases (n = 8), while others were only able to remember 20% (n = 2). These observations are similar to those found in Pulido and Hambrick's (2008) study on vocabulary development, in which they also identified individual differences as a reason for variation in vocabulary retention. This suggests that GT is possibly a beneficial tool for some, but not all learners.

This study discovered that participants were able to successfully learn 10 Dutch phrases (vocabulary items) and their associated pronunciation. After roughly one hour of practice using Google Translate and its speech capabilities, the participants became intelligible and comprehensible, with a low degree of accentedness, according to the native Dutch-speaking raters. Considering that the TTS component of GT was the only aural access the participants had to the target language, these results reinforce Bione and Cardoso's (2020) suggestion that TTS is ready for implementation in L2 pedagogy, particularly because of the quality of its output (i.e., it is intelligible and comprehensible). It also corroborates Liakin et al.'s (2014) findings that ASR has the ability to improve pronunciation if used as a means for implicit feedback. This is the type of feedback we assume ASR is able to deliver (e.g., by comparing the ASR transcriptions of their oral attempt with their intentions, participants could assess their own pronunciation). From a pronunciation perspective, our findings suggest that Google Translate should be considered a valuable tool for use in L2 pedagogy, particularly in SDL contexts (fully autonomous or teacher-structured, as was the case in this study).

Interactions with Google Translate

Individual differences were not only found in the amount of vocabulary retention over time, as discussed earlier. They were also observed in the types of interactions the participants had with GT (e.g., they used different learning strategies to achieve the assigned objectives). The idea that people learn differently has been reported since at least the late 1800s, when the American philosopher John Dewey (1938) established his experimental laboratory in which each student was taught according to their individual differences, shifting away from the emphasis on communal, classroom-based teaching.

Although this study did not examine learning style, it is possible that some participants incorporated their own approach to learning when using the tools available in GT. This was the case in a study by Jie and Xiaoqing (2006), in which the authors argued that their participants' learning styles had significant effects on their choice of learning strategy (e.g., "thinking" learners showed a preference for analyzing and low stress strategies, while "intuitive" learners were inclined to use summarizing strategies). In the context of our study, for instance, it is conceivable that the participants in the TTS-RP-ASR group are predominantly "auditory learners," as their learning strategies prioritized the use of TTS, oral repetition (RP), and the ASR to learn the 10 assigned Dutch phrases. Considering that TTS and ASR are speech-oriented, it is possible that these learners took advantage of their auditory traits such as phonological memory (e.g., the ability to orally memorize vocabulary) to improve their performance. Interestingly, after further investigation of one of the participants who used the TTS-RP-ASR strategy (purely sound-oriented), it was revealed that her performance was considerably above the mean of 121.4 TTS listens: she listened to the TTS 204 times.

This suggests that it may be possible that the participants who used other spelling-based strategies, such as WR-TTS-ASR, are predominantly visual learners (e.g., by writing what they hear or learn).

It is important to note, however, that although our participants were categorized based on 10 "learning strategies," we observed that they sometimes mixed and matched other strategies to achieve their goals (see Naiman et al., 1995, for similar observations). As all of the participants in this study were successful in the posttest, and no strategy seemed to produce more successful learners than others, it shows that GT is a flexible tool that can cater to different kinds of learners.

Conclusion

This study examined GT's pedagogical capabilities as a tool to assist in the L2 learning of phrases and associated pronunciation in a self-direct context, and the interactions between the learner and the technology. The findings indicated that: (a) the participants were able to acquire Dutch vocabulary and pronunciation on a short-term basis, and (b) learners interacted with GT's translation, TTS, and ASR in different ways, demonstrating that GT can be utilized by learners with different approaches to (self-) learning. The main contribution of this study is that it is the first to examine GT as a tool for self-directed language learning in which translation, TTS, and ASR are combined to assist L2 learning.

This study was limited in a number of ways. First, there was no assessment of pronunciation during the delayed posttest because many participants did not remember some of the vocabulary after the two weeks that preceded the test. To address this limitation, future research should consider a methodology that includes the SDL of a foreign language longitudinally, in which participants are encouraged to practice target forms for a sustained period of time, and are given opportunities to practice in a systematic and extensive manner (spaced repetition), as recommended by Ullman and Lovelett (2016). Another limitation includes the number of participants. Although we are confident that our results provide interesting insights about the potential of GT as a pedagogical tool, a larger number of participants would provide a more diverse and potentially reliable sample of language learners. We would also like to acknowledge another limitation that is not exclusive to this study: the novelty effect (Clark, 1983), which is claimed to positively affect performance in the initial stages of the pedagogical implementation of a new technology. As has been observed in other CALL research (e.g., Cardoso, 2011; Liakin et al., 2014), it is possible that the gains observed in vocabulary and pronunciation were merely a result of the participants' initial excitement about GT and its speech-related features. Lastly, although we asked participants to not engage with any Dutch language between the posttest and the delayed posttest, we had no way of ensuring that they followed these directions.

The main pedagogical implication of our findings is that GT has the potential to be used as a pedagogical tool for self-directed language learning via a combination of its translation, TTS, and ASR capabilities, using some of the learning strategies uncovered by our research. Moving beyond the scope of the study, a possible pedagogical implementation of a GT-based, SDL language environment could involve students engaged in language-discovery activities so that they learn the skills to learn and continue to learn on their own ("strategy development"; Chapelle, 2001). For example, students could be asked to find out how to say a phrase in the target language (e.g., "Thank you"), practice it with GT (via translation, TTS, and ASR), and then share their discoveries with other students. Students could then share their discoveries and, consequently, increase their exposure to the target language in more meaningful, personalized ways, without over-reliance on the teacher or classroom materials for L2 input. This encourages learners to be responsible for their own learning, allows them to personalize their learning experiences, and reinforces a learner-centred learning environment (Kassem, 2019).

As this study explored multiple aspects of using Google Translate as a pedagogical tool, it has opened many doors for future research. Future studies should delve deeper into the relationship between language learners and GT, expand this research to other foreign languages, and address some of the study's limitations, as discussed above. Google Translate is continually updating and improving its translation and speech

capabilities. Therefore it is important that the research is brought up-to-date regularly so that language teachers and students are able to make informed decisions on how to use it as a teacher-structured, self-directed pedagogical tool.

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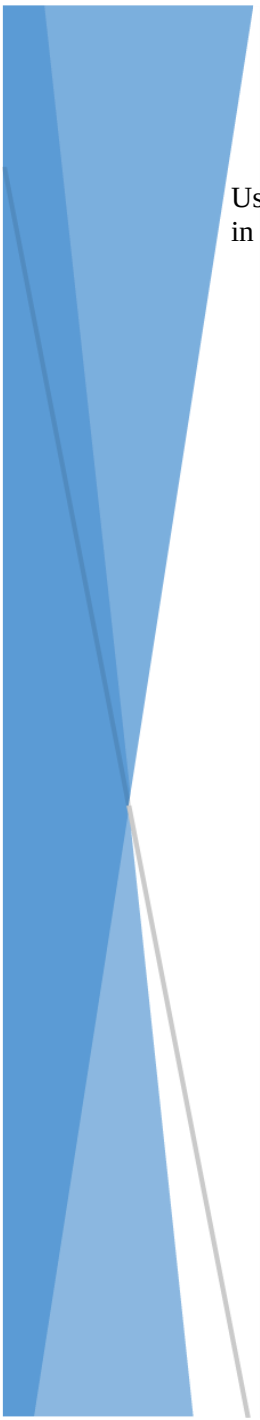
Appendix A

Language Objectives



OBJECTIVES

Using *Google Translate*, learn how to say the following phrases in Dutch during the next 60 minutes or so:

1) “Hello.”

2) “How are you doing?” “Good.”

3) “What is your name?” “My name is …”
(Insert your own name)

4) “Do you speak English?” “Yes” “No”

5) “I don’t understand.”

6) “Speak slowly.”

7) “Please.”

8) “Thank you.”

9) “Bye.”

10) Choose your own phrase to learn in Dutch.

Appendix B

Demographic Questionnaire

Participant's code: _____

1) **Age:** 18-20 21-25 26-30 31-35 36-40 41 and up

2) **Gender** (optional):

3) What is/are your **first language/s**?

4) What **other languages** do you know or speak?

5) Have you ever learned any languages **on your own**? Yes / No
   a. If so, which one(s)?
   b. If so, what tools/books/websites did you use to learn?
   c. If so, what tools/books/websites did you use to learn pronunciation? Which?

6) **How often** do you use Google Translate?
   (Rarely) 1 2 3 4 5 6 (Very frequently)

7) If you use Google translate, **what do you use if for**?

8) What is your **highest level of educational**?
   Primary Secondary Bachelors Masters PhD
   What do/did you study?

9) I enjoy **using technology**.
   (Not much) 1 2 3 4 5 6 (Very much)

10) How interested are you in **learning new languages**?
    (Not much) 1 2 3 4 5 6 (Very much)

11) I am **motivated to learn Dutch** in this study.
    Strongly Disagree 1 2 3 4 5 6 Strongly Agree

12) Have you ever learned or been **exposed to the Dutch language**? If so, please explain.

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