

browser-based multilingual translation

bergamot

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<https://browser.mt>

Deliverable 1.2: User interface for translation

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1 Executive summary

Mozilla has included a browser-based translation User Interface (UX) in its Firefox browser that consists of a row of text and buttons at the top of the browser frame. Currently it uses the services of an online translation service to carry out the translating of text elements within the web page displayed. However, this is only for development and testing purposes as the user interface has to be explicitly activated by setting special parameters in the Firefox `about:config` configuration. For the purposes of our testing and evaluation, we have configured *Google Cloud Translation Services* to be the MT provider for this browser-based translation.

Once configured, the translation UX will appear whenever the browser detects text belonging to a foreign language. It is limited to translating text belonging to language pairs that are included in the MT service. Currently, after pressing a *Translate* button at the top of the browser frame, the entire web page is translated in to the target language (configured in the usual Firefox configuration pages).

Typical UX and Human Computer Interaction (HCI) design principles are used by this browser-based translation utility. This is evidenced by the unobtrusive line of self-explanatory text and buttons at the top of the browser frame which, when activated, generates a new page that retains as many non-textual elements of the original page as possible.

However, there are both UX and HCI considerations that could be adjusted to improve user acceptance and maximise user experience for web page translation. To this effect we have designed and implemented a user testing framework to explore how each aspect of this UX and HCI affects human behaviour. Questions like, What level of control do people want or care about in carrying out the translation? How should the translation UX show the user the page has been translated? Should a mouse-over design be used that translates only parts of the web page? What effect does a delay in the translated page appearing have for the user? What effect do miss-translations have on user experience and acceptance?

We already have some principled recommendations and are carrying out the continuous and iterative design of the translation UX based on experiments with humans for each of these ideas.

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2 The current User Interface for Machine Translation

If people see that a web page has an option to show that page *in their native language*, they would simply take this option. However, it is expensive and cumbersome for organisations to keep multiple language variants of their web portals up-to-date. This is even more poignant for small-to-medium enterprises (SMEs) that cater to international clients. The situation is even more important in the European Union where there are 24 official languages and over 60 indigenous regional or minority languages, the latter alone spoken by more than 40 million people¹.

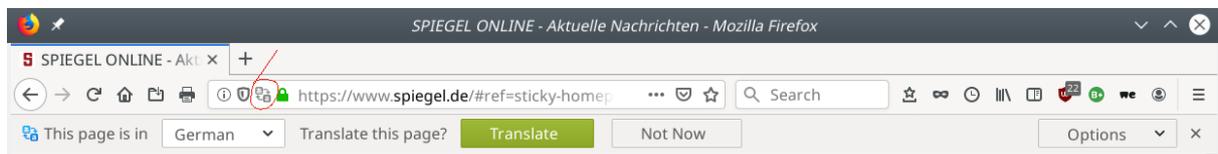


Figure 1: Screenshot of the translation UX at the top of the browser screen. It consists of an icon to the left of the Address bar and a row of self-descriptive text and buttons.

Mozilla have built in to its Firefox browser a development User Interface (UX) with code that employs an external service to translate the current web page (Figure 1). While this UX is not for public consumption, it does allow us to explore different UX design options for the future public translation UX addon that is being developed by the *Bergamot* project. Figure 2 shows an example of the UX with a German page displayed, and Figure 3 shows the same page translated in to English. The governing UX design principles for this initial translation interface were to be as unobtrusive for the end-user as possible. Despite being switched off by default in the browser (see Figure 4), this facility does have the potential to be accessed by millions of Firefox users across Europe and worldwide.

The current UX (Figure 1) consists of a row of buttons at the top of the screen that allows the user to choose the source language from a drop-down list of possible languages, and a pair of buttons to either *Translate* or *not translate* the web page. There is also a close-box icon to the very right which removes the translation UX from the top of the browser frame.

To the right of this UX line there is a drop-down *Options* button offering to either (i) never translate the source language, (ii) never translate this site, or (iii) to take the user to the Firefox configuration page where they can set their target language among other general browser options.

In this initial development phase, the translation service must be previously setup with Firefox's *about:config* configuration tool² (Figure 4). In

¹ https://europa.eu/european-union/about-eu/eu-languages_en, the European Union's official page describing the languages spoken therein (English version).

² The production version of the translation UX addon will have a more user-friendly setup.



Figure 2: Example screenshot of the German *der Spiegel* web page, with the translation UX at the top. Notice how the translation icon to the left of the address box is greyed out when showing untranslated text.

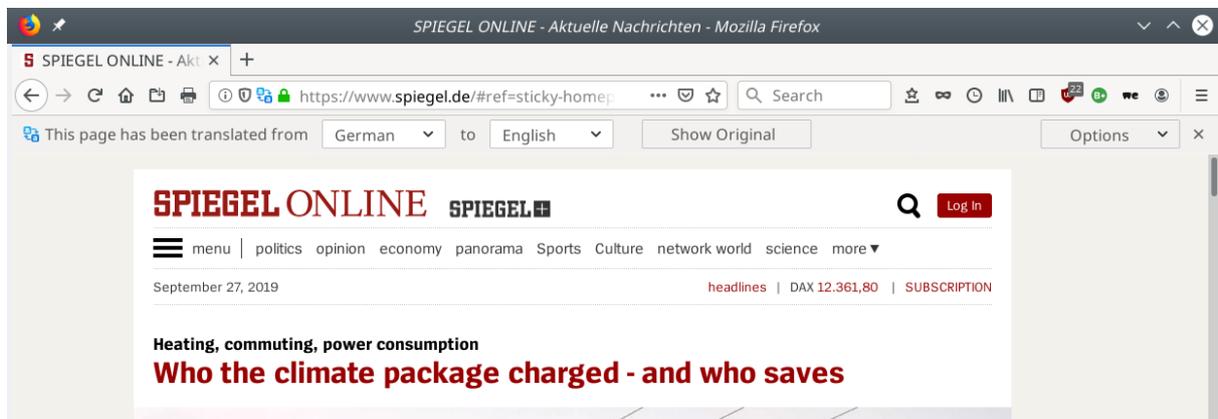


Figure 3: Screenshot of the German *der Spiegel* (Fig. 2) web page now translated in to English. Notice how the translation icon to the left of the address box is now coloured, showing that the page has been translated.

the case of the Google translation service, this must be activated via *Google Cloud Services* (which for organisations implies a financial commitment).

Once the translation UX is set-up (Figure 4), its icon can be clicked to toggle the translation UX buttons. Upon clicking the *Translate* UX button, the separate text elements are sent to the external service and a few seconds later Firefox re-displays the web page with the translated text (Figure 3), preserving the overall visual elements and design of the web page (layout, images, CSS processing, etc.).

Note that the translation UX is limited to working with language pairs that are covered by the back-end translation service. See Figure 5 for an example of how to choose another source language. This list of possible languages should initially only show those languages that are incorporated in to the MT system. Although a wide range of language pairs is beyond the scope of the current Bergamot project, it is still important to determine user demand for machine translation at scale. Hence it is useful to have

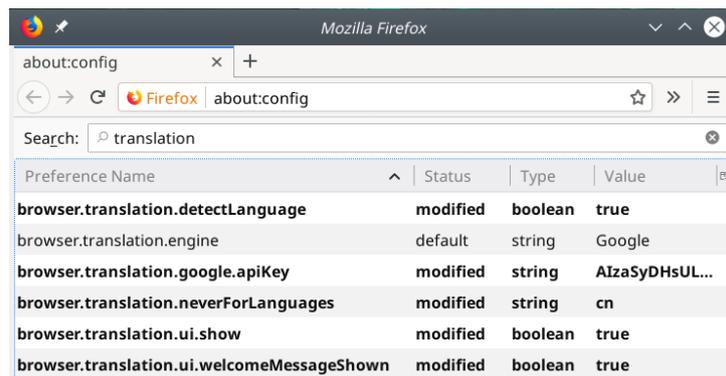


Figure 4: Screenshot of the relevant *about:config* UX translation parameters for Firefox

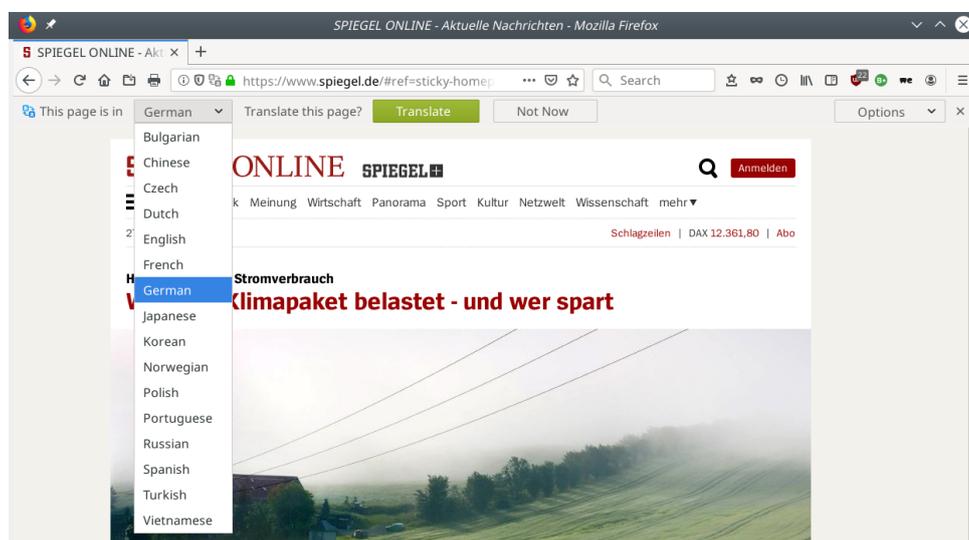


Figure 5: Example screenshot of the possible languages that can be translated from (and to).

an option to display a wider selection of languages for evaluation purposes. As per standard UX considerations, translation should *just work*, showing the complete web page in the user's target language (assigned via Firefox Configuration options).

The user knows that they are looking at a translated page by the colour of the Firefox translation icon to the left of the Address bar (see Figures 2 and 3), as it will be greyed out for untranslated web pages. This in itself is an important usability feature as it provides an indicator of whether what is being displayed is the original source (untranslated) or an MT translated (and therefore unofficial) version with its associated miss-translation risks.

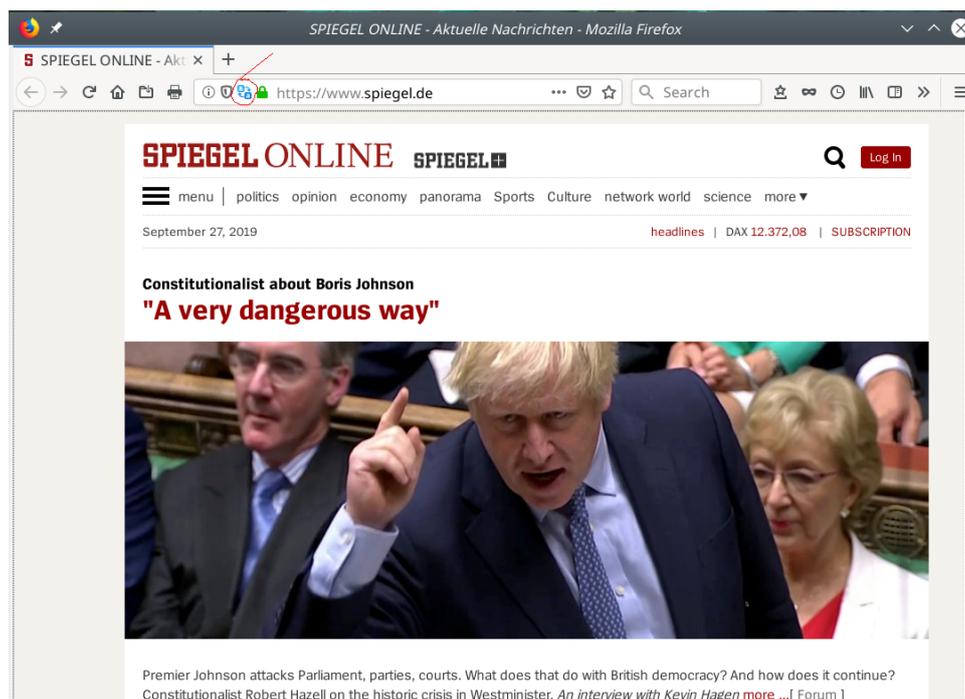


Figure 6: Example screenshot showing the coloured Translation icon without the top-line Translation UX (which can be made to appear by clicking the Translation icon). Note how this translated page contains awkward/unnatural and linguistically incorrect MT-translated English sentences.

3 Next steps in the development of the Translation UX

Different options for the translation UX need to be tested with humans in order to ensure optimal user acceptance. Hence, the primary objective of the next stage of the UX design is to test the interface with humans in controlled attentional experiments. To this end we have set up an experimental UX with which we can carry out multiple evaluation scenarios to test how adult native speakers (initially English speakers) react to text that has been translated into English by NMT.

We are looking for markers and trends in human behaviour in relation to reading of English text that has been machine translated from languages within the *Bergamot* list of candidate languages. We are going to be testing how people's eye movement, heart rate, facial expression and galvanic skin responses change according to (a) UX design considerations; (b) how long they have to wait for the translation to appear; (c) correctness of translation (both correct and typical miss-translation errors produced by MT; see Figure 6 for example); and (d) how any prior knowledge of the source language impacts on behaviour. The target population includes the general public who would be reading material sourced only in a foreign language on the internet. The level of difficulty and specificity of the material is taken

to be typical newspaper text.

3.1 Testing design considerations for UX improvement

There are various options and alternatives for improving the UX. As it stands, the current UX could benefit by removing redundancies like an extra button to *not translate* the page, as well as a close-box icon to the right. We will also explore:

- What level of control do people *want* or *care* about? Should there be an option to always *Auto translate*? This could be set in the browser setup.
- Should the Translation icon indicate more explicitly that the web page has either been translated or is displayed in its original version?
- How should the source language identified? HTML allows for "lang=" attributes in all element types, but what if the original web page does not use these attributes? Should the user be provided a choice (as in Fig. 5)?
- What about mixed languages in the web page? Should this be identified on the source page for the user to see?
- Should only parts of pages be translated (e.g. only mouse-over text elements)?
- Should translated text be shown in a pop-up window when mouse-over, and leave the web page in its original version?
- What should happen if there is no MT model for the source and target language pair?
- Do people care whether translation preserves original look-and-feel of the original web page?
- Once the translated page appears, do people want to revert back to foreign language version in a mouse-over window, or swap the entire web page as currently happens?
- How should the option of *outbound* translation be shown to the user? See 5 below for current development in *outbound* translation.

The next stage in the development of the Bergamot Translation UX will address the practicalities of running the MT models on limited-capacity user PCs. In assuming local RAM, hard drive space and computing capacity limitations, the MT models will have to trade-off between speed and quality of translation. In particular, we will explore these two aspects in the ensuing set of experiments that will simulate these conditions, to see what effects

they have on user acceptability and user tolerance. We aim to objectively parameterise MT delay and accuracy (a proxy for quality estimation) in order to maintain a functionally competent and usable translation UX. This, together with the above considerations for the UX design, will comprise the bulk of the next phase of our work.

4 User behaviour and Human Computer Interaction experiments

As we will be analysing people's responses (especially eye movements and other attentionally mediated human behaviour) to web content, we are using the *iMotions* research suite³ *iMotions* includes an API that allows it to be updated with external information. Hence we are showing HTML content on a locally hosted server in order to manipulate the web material shown to participants (see Figure 7).

4.1 Simulating CPU delay and MT miss-translations

Currently, a user who requests a web page to be translated into their preferred language has to wait a few seconds for the translated page to appear. We will test to see how simulated delays from 700ms to 4000ms impact on the user. We achieve this by showing a source foreign language sentence, allowing the user to press the *Translate* UX button and then waiting an amount of time (dependant on the delay condition) before displaying the English sentence. In the meantime we are collecting eye movements, facial expressions, heart-rate and galvanic skin responses from the participant. The relevant documents that participants need to read and sign have been approved by the University of Edinburgh Ethics committee and are included in the Appendix.

In a second experimental manipulation, the target English sentence will be either correct or have an error consistent with typical MT miss-translations. This is to simulate the effect of the quality of the MT output (see Figure 6 for an example of how MT can incur in these errors) and how users respond to degraded translations. In particular, we will show English sentences (translated from German sentences in the first instance) that are either (i) correctly translated; (ii) contain a word-order error; (iii) contain a lexical error; or (iv) contain an error in tense or agreement. Table 1 shows some examples of such errors.

The German source and English translations were taken from material developed for the *CasMacat*⁴ research project. The translations were veri-

³ <https://imotions.com/>, To aid in the “unpacking of human behaviour”.

⁴ <http://www.casmacat.eu/> A research project entitled, “Cognitive Analysis and Statistical Methods for Advanced Computer Aided Translation”, that ran at Edinburgh University

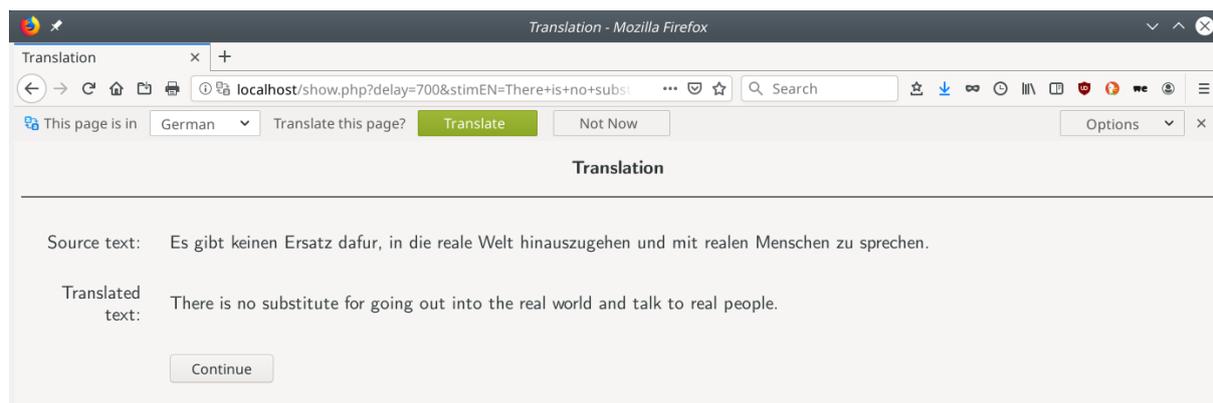


Figure 7: Screenshot of the Translation UX with a locally hosted PHP script to show HTML GET parameters. In this screenshot the English translation has a tense agreement error ("talk", but the correct word is "talking"). In this example the English sentence appeared after a 700ms delay.

fied by twelve professional translators. In all, there were 120 sentences in each type of error condition.

Table 1: Examples of typical MT errors

Error type	English sentence
Word Order	Greece needs a <i>programme new</i> of adjustment to rescue its economy.
Lexical	Some came in the hope of being able to <i>see</i> Stalin in the eye.
Tense or Agreement	The public increasingly <i>acting</i> as if it feels sorry for those in uniform.

After each sentence pair has been shown and the participant presses the *Continue* button, a questionnaire screen appears and participants must respond a question about the translation with a five point *Likert* scale. As participants will be seeing 240 sentence pairs, the actual question asked will change so as to avoid repetition behaviour in the participant.

4.2 Analysis

Both the questionnaire data together with the eye tracking and biometric data will be modelled by error types and delays with mixed effects models in R (R Core Team, 2019; Bates et al., 2015; Pinheiro et al., 2019). We will be looking at whether participants are affected by delays and error types, and if so, to what extent these trade-off situations will impact on user experience.

between 2012 and 2014. Its aim was to develop a tool to assist human translators. Twelve professional translators translated typical German newspaper text in to English.

5 Other UX considerations

Members of the *Bergamot* team at Charles University have produced an UX to test outbound translation (Figure 8). This research will be incorporated into the Translation UX, as it will include an option for outbound translation when web forms have to be filled in. More details can be found in the accompanying document entitled, "Interim Report on Source Complexity and Outbound Translation".

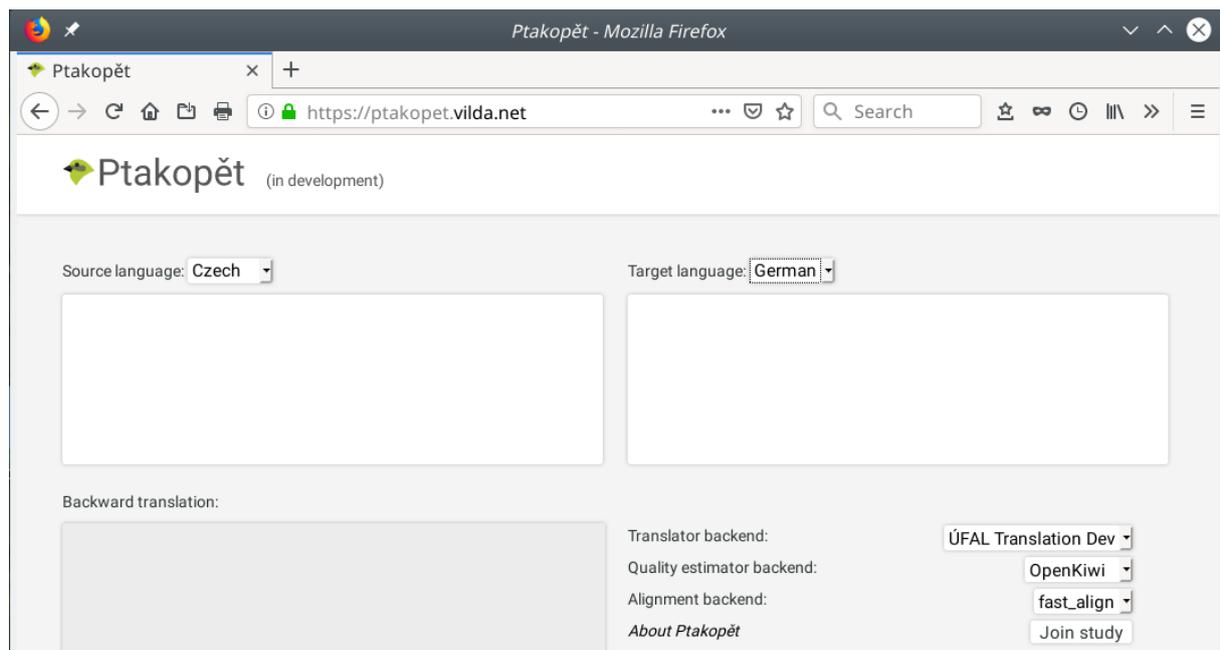


Figure 8: Example screenshot showing Ptakopet, a tool developed by Charles University to test outbound translation

6 Conclusion

The translation UX included in the Firefox browser provides us with a test-bed to explore and develop a continuous and iterative UX and HCI development environment for web page MT. We have designed and implemented an experimental environment with humans to evaluate key visual and functional elements of the translation process so as to maximise user experience in web page translation.

References

Bates, Douglas, Martin Mächler, Ben Bolker, and Steve Walker. 2015. "Fitting linear mixed-effects models using lme4." *Journal of Statistical Software*, 67(1):1-48.

Pinheiro, Jose, Douglas Bates, Saikat DebRoy, Deepayan Sarkar, and R Core Team. 2019. *nlme: Linear and Nonlinear Mixed Effects Models*. R package version 3.1-141.

R Core Team. 2019. *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing, Vienna, Austria.

Appendix

The following documents are required by the University of Edinburgh for experiments involving humans:

- Participant Information Sheet, 3 pages
- Participant Consent Form, 1 page

Participant Information Sheet

Project title:	Human perception of machine translated text
Principal investigator:	Dr. Mateo Obregón
Researcher collecting data:	Dr. Mateo Obregón
Funder (if applicable):	Horizon 2020

This study was certified according to the Informatics Research Ethics Process, RT number 4058. Please take time to read the following information carefully. You should keep this page for your records.

Who are the researchers?

- Principle Investigator: Dr. Mateo Obregón (mateo.obregon@ed.ac.uk)
- Lead researcher: Dr. Robin Hill (r.l.hill@ed.ac.uk)

What is the purpose of the study?

The goal of this research is to explore how humans perceive machine-translated text that is shown in a browser on a computer. To accomplish this, we will be recording eye movement, heart rate, facial expression, galvanic skin response and answers to questions regarding translated text that is shown in a browser environment on a computer.

Why have I been asked to take part?

We are inviting adult native English speakers with normal or corrected-to-normal binocular vision to participate in this research.

Do I have to take part?

No – participation in this study is entirely up to you. You can withdraw from the study at any time, without giving a reason. Your rights will not be affected. If you wish to withdraw, contact the PI. We will stop using your data in any publications or presentations submitted after you have withdrawn consent. However, we will keep copies of your original consent, and of your withdrawal request.



What will happen if I decide to take part?

If you decide to take part, you must first sign the Participant Consent Form. You will then be comfortably seated in front of a computer with a desktop-mounted eye-tracker in front of you. The researcher will place a heart-rate electrode on an earlobe and a set of galvanic skin response (GSR) receptors on two fingers of your non-dominant hand.

You will first complete a brief questionnaire about you, including an assessment of your bilingual knowledge of German. The researcher will then calibrate the eye-tracker and make sure that the heart rate monitor and GSR receptors are working properly. You will be shown a set of instructions and given a few test trials to make sure the equipment is working and that the instructions are clear for you. Following this, you will be shown blocks of short newspaper-style texts for you to read. You will press a button when you have finished reading the text and then you will be shown a set of multiple-choice questions regarding the text you just read.

You will be given multiple experiment blocks with short breaks in-between. The experiment lasts for about than an hour, at the end of which you will be thanked and paid for your participation.

Compensation

You will be paid £10.00 for an hour of your participation in this study.

Are there any risks associated with taking part?

There are no significant risks associated with participation.

Are there any benefits associated with taking part?

Your benefit will consist of monetary compensation for taking part in this study.

What will happen to the results of this study?

The results of this study may be summarised in published articles, reports and presentations. Quotes or key findings will be anonymized: We will remove any information that could, in our assessment, allow anyone to identify you. With your consent, information can also be used for future research. Your data may be archived for a minimum of two years.



Data protection and confidentiality.

Your data will be processed in accordance with Data Protection Law. All information collected about you will be kept strictly confidential. Your data will be referred to by a unique participant number rather than by name. Your data will only be viewed by the research team, namely Mateo Obregón and Robin Hill.

All electronic data will be stored on a password-protected encrypted computer, on the School of Informatics' secure file servers, or on the University's secure encrypted cloud storage services (DataShare, ownCloud, or Sharepoint) and all paper records will be stored in a locked filing cabinet in the PI's office. Your consent information will be kept separately from your responses in order to minimise risk.

What are my data protection rights?

The University of Edinburgh is a Data Controller for the information you provide. You have the right to access information held about you. Your right of access can be exercised in accordance Data Protection Law. You also have other rights including rights of correction, erasure and objection. For more details, including the right to lodge a complaint with the Information Commissioner's Office, please visit www.ico.org.uk. Questions, comments and requests about your personal data can also be sent to the University Data Protection Officer at dpo@ed.ac.uk.

Who can I contact?

If you have any further questions about the study, please contact the lead researcher, Dr. Robin Hill: r.l.hill@ed.ac.uk.

If you wish to make a complaint about the study, please contact inf-ethics@inf.ed.ac.uk. When you contact us, please provide the study title and detail the nature of your complaint.

Updated information.

If the research project changes in any way, an updated Participant Information Sheet will be made available on <https://web.inf.ed.ac.uk/infweb/research/study-updates>.

Alternative formats.

To request this document in an alternative format, such as large print or on coloured paper, please contact Dr. Mateo Obregón: mateo.obregon@ed.ac.uk.

General information.

For general information about how we use your data, go to: edin.ac/privacy-research



Participant number: _____

Participant Consent Form

Project title:	Human perception of machine translated text
Principal investigator (PI):	Dr. Mateo Obregón
Researcher:	Dr. Mateo Obregón
PI contact details:	mateo.obregon@ed.ac.uk

Please tick yes or no for each of these statements.

- | | Yes | No |
|--|--------------------------|--------------------------|
| 1. I confirm that I have read and understood the Participant Information Sheet for the above study, that I have had the opportunity to ask questions, and that any questions I had were answered to my satisfaction. | <input type="checkbox"/> | <input type="checkbox"/> |
| | Yes | No |
| 2. I understand that my participation is voluntary, and that I can withdraw at any time without giving a reason. Withdrawing will not affect any of my rights. | <input type="checkbox"/> | <input type="checkbox"/> |
| | Yes | No |
| 3. I agree to having my eye movements, my heart rate, my facial expressions and my galvanic skin responses recorded and analysed. | <input type="checkbox"/> | <input type="checkbox"/> |
| | Yes | No |
| 4. I consent to my anonymised data being used in academic publications and presentations. | <input type="checkbox"/> | <input type="checkbox"/> |
| | Yes | No |
| 5. I understand that my anonymised data can be stored for a minimum of two years | <input type="checkbox"/> | <input type="checkbox"/> |
| | Yes | No |
| 6. I allow my data to be used in future ethically approved research. | <input type="checkbox"/> | <input type="checkbox"/> |
| | Yes | No |
| 7. I agree to take part in this study. | <input type="checkbox"/> | <input type="checkbox"/> |

Name of person giving consent	Date dd/mm/yy	Signature
_____	_____	_____
Name of person taking consent	Date dd/mm/yy	Signature
_____	_____	_____

