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Eyetracking methodology in SCMC: a tool for empowering learning and teaching

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Abstract

Computer-assisted language learning, or CALL, is an interdisciplinary area of research, positioned in tension between science and social science, computing and education, linguistics and applied linguistics. This paper argues that by appropriating methods originating in some areas of CALL-related research, for example, HCI or psycho-linguistics, the agenda of 'attention-focus' research can be shifted from a cognitive perspective to a learner-centred approach, understanding online language learning and teaching spaces as mediated by technology, second/foreign language, and online teaching culture.

Taking a method that has traditionally been used within a positivist paradigm, the authors exemplify the potential of eyetracking to progress online language learning research - extending it in ways compatible with a sociocultural paradigm. This is evidenced by two pioneering studies in which an innovative combination of methods allows participants, whose gaze focus during synchronous computer-mediated communication (SCMC) has been recorded, to reflect back on their involvement. Eyetracking is combined with stimulated recall interviews that trigger deep reflection on learner and teacher strategies by directing participants' recollections on their attention focus.

The rich, multifaceted results shown by this original and innovative use of eyetracking methods in a sociocultural framework direct a way forward in researching online learning by integrating insider and outside views coherently and systematically.

Key words

eyetracking, SCMC, sociocultural, methodology, online language learning

1 Introduction

Eyetracking is a relatively new approach in the research area of second language learning and teaching and is just making its way into the study of computer-assisted language learning (CALL) and synchronous computer-mediated communication (SCMC). In two pioneering studies we demonstrate how the combination of eyetracking with other, more qualitative methods, can be used within a sociocultural paradigm (Authors, in preparation; Author, 2015; Authors, 2014, 2015b). This paper will set the context of qualitative and mixed-method studies in CALL, evaluate eyetracking as a method for Second Language Acquisition (SLA) research in a psycholinguistic context, and describe an expanded method adding a usability perspective taken from Human-Computer Interaction (HCI) research, before moving the method on towards its potential use in SCMC research within a sociocultural paradigm.

1.1 Innovative approaches in CALL research

In their CALL journal Editorial, Mike Levy, Philip Hubbard, Glenn Stockwell and Jozef Colpaert (2014) identify questions of pedagogy, design and research as the most pressing in our field. They position CALL in a space between different disciplines, which makes CALL research fundamentally interdisciplinary (see also Author & colleague, 2015) and embraces a wide variety of research methods. As Author & colleague (2015a) have shown, occupying this space between different disciplines and their fundamental, but often unspoken, tenets is at the same time promising and challenging - not least because selecting methods that originate in qualitative or quantitative paradigms and combining them to form new and innovative methodological approaches necessitates an understanding of the underlying ontologies and epistemologies (Riazi & Candlin, 2014).

This paper adopts a sociocultural paradigm (Block, 2003; Lantolf & Thorne, 2007; Vygotsky, 1978) emphasising that all our actions are influenced by the social and cultural contexts in which they take place, and these in turn are based on historical developments. For Vygotsky mediation through language is one of the fundamental ways of mediation allowing humans to achieve “higher mental functions” (Vygotsky, 1978). Taking a sociocultural perspective is thus relevant in language learning situations (Block, 2003), and even more so in language learning online (Bee Bee & Gardner, 2012), as the communication is mediated in two ways: through the use of a second language (Lantolf, 2000), and through the technology employed with its affordances (Dougiamas, 1998; Lamy & Hampel, 2007; Wertsch, 2007). Mediation through technology is another of Vygotsky’s basic examples of mediation, also already well researched (Hampel, 2009) in online language learning.

As a research paradigm, sociocultural theory (SCT) places the CALL researcher at the crossing point of theory (or ‘research’) and practice (or ‘pedagogy’): the knowledge that all action is mediated (Wertsch, 1994) makes the context of a study part of its field and encourages a) naturalistic or ecological studies, b) the collection of rich data, and c) methods of analysis that involve participant checks and reflection. The conviction that every action is meaningful (Schwandt, 2000) makes the researcher responsible for the outcomes, in terms of research findings or knowledge generation

and also in a wider sense for the change engendered by the research, the influence on practice, and – in our field – the improvement of pedagogy or learning opportunities, as Lantolf & Thorne (2007) state:

> Because of its emphasis on praxis, SCT does not rigidly separate understanding (research) from transformation (concrete action). While SCT is used descriptively and analytically as a research framework, it is also an applied methodology that can be used to improve educational processes and environments. (Lantolf & Thorne, 2007, p. 216)

CALL research over the past decade has shifted from predominately quantitative studies to a more conscious employment of qualitative methods in mixed approaches or ecological studies (see Benson, Chik, Gao, Huang, & Wang, 2009). As Levy and colleagues point out, this has also led to a selection of methods from a range of different disciplines.

> Frequently, those working in CALL do not simply transfer research methods or designs from cognate disciplines, or if they do, important adjustments are made while in transit. Sometimes the method or design in CALL is quite unique or distinctive. (Levy et al., 2014, p. 4)

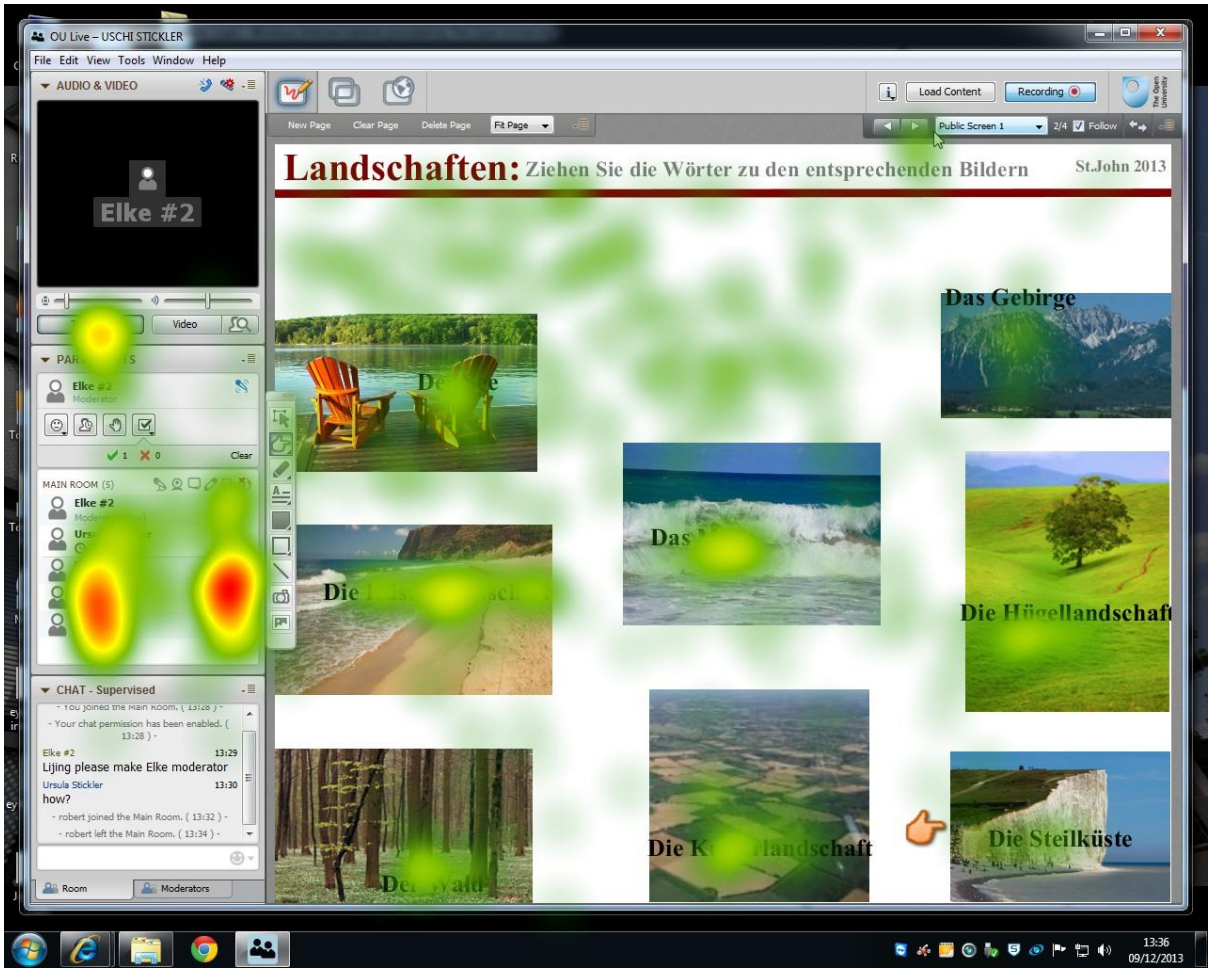
These innovative approaches have resulted in a richness of data and insights (see for example, the studies assembled in the Special Issue of the CALICO journal devoted to qualitative methods in CALL (CALICO 32, 3, 2015)). What is sometimes still missing is a clear description of the theoretical foundations and the sources of methodological inspiration (see also Riazi & Candlin, 2014).

1.2 Eyetracking research in CALL

Eyetracking can show where a person's gaze is focused at a particular time ("fixation"). From this information it is possible to draw certain conclusions about the attention focus of the user (Just & Carpenter, 1976). Eyetracking as a research method has been used for over 100 years in the field of linguistics (Jacob & Karn, 2003), first and foremost as a method in reading research: by recording the gaze fixations of readers, i.e. where a person's gaze is focused at a particular time, linguists investigated the process of reading (Rayner, 1978, 1998).

Nowadays, in addition to the computer generated statistical information eyetracking data can be represented visually in videos and images. Like other video recordings, the visual information is available for scrutiny immediately after the collection of data but eyetracking has specific advantages over other visual data: a) it adds a layer of information to a simple recording of screen interactions, and b) it can cluster this information (see Illustration 1 for an example of a heatmap and Illustration 3 for an example of a gazeplot image) showing cumulative attention focus points[i].

Illustration 1: Heatmap of German teacher



As visual data representation becomes increasingly important amongst the communicative formats we use in the 21st century, eyetracking can be confirmed as a current and relevant method to present research data[ii].

Leow, Grey, Marijuan and Moorman (2014), in their article comparing different research methods, point towards an increased interest in SLA to investigate internal processes of learners during language learning. The three methods they investigate in detail are Think-Aloud-Protocols, eyetracking, and measuring the response time, for the investigation of cognitive processes, elaborating on shortfalls of all. In their judgement, "… ET [eyetracking] is arguably the most robust measure of learner attention given the rich data it gathers in relation to participants' eye movements." (p.117). The "recent prominence" of eyetracking for investigating cognitive processes in SLA was confirmed in the introduction to the Special Issue of the journal Studies in Second Language Acquisition (Winke, Godfroid, & Gass, 2013, p. 205).

> This special issue is devoted to eye movements by L2 learners in the belief that, through these data, researchers will gain a better and more complete understanding of the processes of L2 development. (Winke et al., 2013, p. 207)

Most of the articles in the special issue compiled by Winke, Godfroid and Gass, as indeed most SLA eyetracking studies in the past, are interested in a cognitive perspective and deal mainly with experimental studies. Even those concerned with 'ecological validity' (Spinner, Gass, & Behney, 2013) conclude that a more

naturalistic setting might have to be sacrificed in favour of unrealistic tasks to gather more reliable and comparable data: they obtained more accurate data by enlarging the font of the text example and changing the layout, resulting in a format that does not compare to students' normal reading material.

Eyetracking studies investigating communication in online shared spaces, i.e. synchronous computer-mediated communication (SCMC), are rare. Bryan Smith (Smith, 2010, 2012), Breffni O'Rourke (2012), Marije Michel (Smith & Michel, 2014), and Therese Örnberg Berglund (Berglund, 2012) are amongst the few to have tackled this challenging task. Based on a Symposium at the 2013 WorldCALL conference, O'Rourke and other members of the panel (Authors & colleagues, in press) point out reasons why this might be the case: although eyetrackers are becoming more widespread and easily available, the research design of eyetracking when users are engaged in real communication and work with a screen that changes often and in unpredictable ways, is still challenging. And in this developing field, research methodologies are not yet firmly established; as Spinner, Gass and Behney note:

> As SLA researchers become more sophisticated in their use of eye-trackers, they will need to move away from reliance on methodologies established by researchers in other fields, given the different foci of the research questions. (2013; p. 390)

In a contribution to Caws' & Hamel's (in press) collection of new methodological approaches in CALL research, Authors & colleagues (in press) attempt to show the additional benefits of applying eyetracking to SCMC research. The uniqueness of the direction taken in our research can best be appreciated from a more traditional understanding of eyetracking: following the eye movements on already moving screens poses an additional technical challenge; analysing the data gathered from the eyetracker itself and combining this with additional layers of information makes our method complex but also relevant for answering future questions of language learning online. For example, future questions could include: "What do learners and teachers pay attention to during synchronous online interaction?", "What areas of the screen attract attention and why?", "What is the influence of formal or informal settings on attention patterns and awareness?", "What happens during phases of silence and apparent inactivity during online language learning sessions?" Our own experience in SCMC research (Authors, 2015b) is grounded in a sociocultural perspective and we are aware that the 'unexpectedness' and the resulting 'messiness' of data are a natural part of communication. It is therefore necessary to find a way of integrating eyetracking into a methodology that can cope well with more naturally occurring language learning and teaching.

2 Combining methods systematically

The research presented in this paper – while rooted in sociocultural theory – draws on methods from a variety of fields. From psychology and psycholinguistics we take the inspiration of looking at learners' eye movements to draw conclusions about the focus of their attention at any given moment (Just & Carpenter, 1976; Rayner, 2009). In this perspective, fundamentally a positivist stance, data gains in validity by being objective, i.e. a look from the outside onto learners' experience of language learning.

The richness of detail and the accuracy of measurements and recordings are appreciated by researchers in this field whereas questions of subjective interpretation and context are largely left aside.

HCI research makes more practical and pragmatic use of eyetracking for the examination of online spaces (Poole & Ball, 2006), for example websites. The users' experience here is of more importance and therefore some HCI eyetracking experts (e.g. Nielsen & Pernice, 2010) and SLA researchers (Godfroid, Housen, & Boers, 2010) recommend combining eyetracking with other methods, e.g. stimulated recall, to achieve more clarity on the meaning of their findings. However, our distinctive mix of methods develops eyetracking substantially beyond its forms of use by HCI researchers or psycholinguists, i.e. beyond a purely pragmatic or objectifying stance, mainly interested in exploring the internal psychological processes of research participants and proving their relevance for, and fit with, language learning tenets. We also eschew the danger of limiting ourselves to a positivist paradigm as, in our studies, participants play a central role in contributing their reflections, thoughts and insights. Furthermore, the participants' reflections support their own awareness raising and help them to develop as learners and teachers.

Educational research provides us with the methods for investigating learners' or teachers' thought processes and reflective practice (Hammersley, 2005). Finding out what learners think has taken two different approaches traditionally: on the one hand observations from the outside are used to establish more or less tentative connections between observable behaviour and thought. Examples for methods in this perspective are keystroke and screen recordings, reaction time studies and classical eyetracking studies. On the other hand, introspective data are generated by asking learners to verbalise their own thinking processes and use recollection or reflection to share these processes with the researcher. Examples from this strand include think-aloud protocols and stimulated recall interviews.

Gass & Mackey (2000) show how Stimulated Recall (SR) can be used in applied linguistics research in general. Introspective methods are often hampered by a lack of memory. Presenting a stimulus can aid this memory and make recollections more accurate. The emphasis of Gass & Mackey's approach to SR is still on veracity of recollections, their potential to capture "true" representations of learners' thought processes, although they are aware of the subjectivity of recall and descriptions from the learners' perspective.

More recently, SR has also been employed to explicitly aid reflection: the stimulus is used to access a deeper level of the participants' thoughts on their past actions. These would include memories of reasons for action and descriptions or speculations on processes. Messmer (2015), for example, employs SR to fuel deeper reflection as well as making thought processes of teachers visible. He uses SR for the investigation of how teachers make decisions about their teaching. His study is based on video recordings of face-to-face classroom interactions, and he shows that teachers use four types of reasoning to describe their actions retrospectively: explanation (*Erklärung*), justification (*Begründung*), vindication (*Rechtfertigung*), and conclusion (*Folgerung*). In addition to the knowledge generated by this qualitative analysis, he also claims that SR acts as an encouragement for deep reflection in teachers.

> Der Zusammenhang von Methode und Fragestellung scheint insbesondere in Bezug auf die Untersuchung von Denkprozessen nicht unbedeutend. Inwiefern LehrerInnen sich in einem Reflexionsprozess an ihre ursprünglichen

> Gedanken "erinnern", hängt explizit auch vom methodischen Vorgehen ab (Messmer, 2015, n.p. §4)
>
> (The relation between method and research question seems to be particularly relevant in connection with the investigation of thinking processes. How far teachers 'remember' their original thoughts during the reflective process will also depend explicitly on the methodological procedures. – our translation)

From the field of CALL, we take the general direction for future research as outlined by Levy and colleagues (2014) and also specific ideas on involving research participants as co-investigators, as for example, proposed by Cutrim Schmid (2011). In her longitudinal study on the use of whiteboards in face-to-face classrooms, Cutrim Schmid engages teachers to reflect on their own teaching using video recordings of classroom interaction that involve the use of digital whiteboards for language teaching.

Our methodological approach with its specific combination of methods allows us to look at mediated action (Wertsch, 1994) as a basis for learning in online spaces; the reflections of our participants can offer valuable insights into this. In our approach, combining eyetracking data with participant's stimulated recall data, we aim at generating insights into observable learner and teacher behaviours ("true recollections" of thought processes), and reflections on these processes. We even go beyond that by taking our participants' reflections as an integral part of the research process. Together with them we speculate on reasons for their actions in context, we can judge them as typical or atypical, we evaluate them – in a dialogue – as helpful or hindering their learning and teaching processes. Our claim is that our methodological approach is unique in generating these insights; however, we want to establish that this is the case.

In brief, our research questions are:

- Does our specific combination of methods help us – as researchers and as participants – to understand the process of online language learning and language teaching better?
- Does this specific combination of methods benefit the participants in developing their online language learning and language teaching skills and strategies?
- Does this specific combination of methods fit within a socio-cultural framework and add to its explanatory / hermeneutic power?

In the subsequent sections we will show how eyetracking, as a method originating in psychology and adopted by HCI for usability studies, has the potential to enrich the socioculturally-based research on online language learning. We will first describe a unique mix of methods deploying eyetracking and how this was used in two studies. Following the project description and findings we will discuss the methodology used, in its epistemological context and compared to other options. We will show the benefits of starting with an explicitly sociocultural paradigm. Finally, we will suggest some options for future studies.

3 A mixed-method eyetracking model for SCMC: description

Eyetracking is an excellent method to record the gaze focus of users engaged in working on a screen. Our studies employ the principles of eyetracking during synchronous computer-mediated-communication (SCMC) tasks combined with a stimulated recall interview immediately following the online task.

In a laboratory setting, an online language learning task, mirroring as closely as possible a naturalistic task, is set up. Participants are introduced to the task and the laboratory, explaining in detail what our research questions and our methods are, how eyetracking works, and what specific contributions are expected of them. The laboratories have integrated ceiling video cameras to record participants during their interaction with the computer or with other people in the room.

Before the actual online eyetracking task, we collect some baseline data from participants; either in the form of a short biographical questionnaire (students) or during a short pre-study interview asking for previous teaching experience (teachers). Then the eyetracker needs to be calibrated for every individual user to achieve close approximation of the actual gaze focus. When these preliminary steps are concluded, we start the actual eyetracking.

As the tasks are carried out in a synchronous CMC environment, the set-up needs to be carefully planned, so that all participants are ready at the same time. During the task, the eyetracker records the gaze focus, and this data can be immediately converted into gazeplot videos, a standard representational format for eyetracking data showing how participants' eye focus moves on the screen (see Illustration 3 for a still image of a gazeplot). These video-clips are played back to the participants after the completion of the online task, forming the basis of the stimulated recall interview. The gazeplot video is repeatedly stopped to allow participants to describe in detail what they noticed about their behaviours.

Core data for our project comprises: 1) ceiling camera recordings of participants' interaction with the computer, 2) eyetracking data including gazeplot videos, heatmaps, fixation count and duration, and other statistical measures recorded by the eyetracker, plus 3) screen recordings of the online tutorial interactions, and 4) recordings of stimulated recall interviews. Together with baseline questionnaires and follow-up questionnaires, field notes taken by the researcher present either in the lab or in the observation room, and follow-up notes and comments from the participants, these data form a rich and complex source of information about online learning and teaching.

3.1 Two mixed-method eyetracking studies: participants and procedures

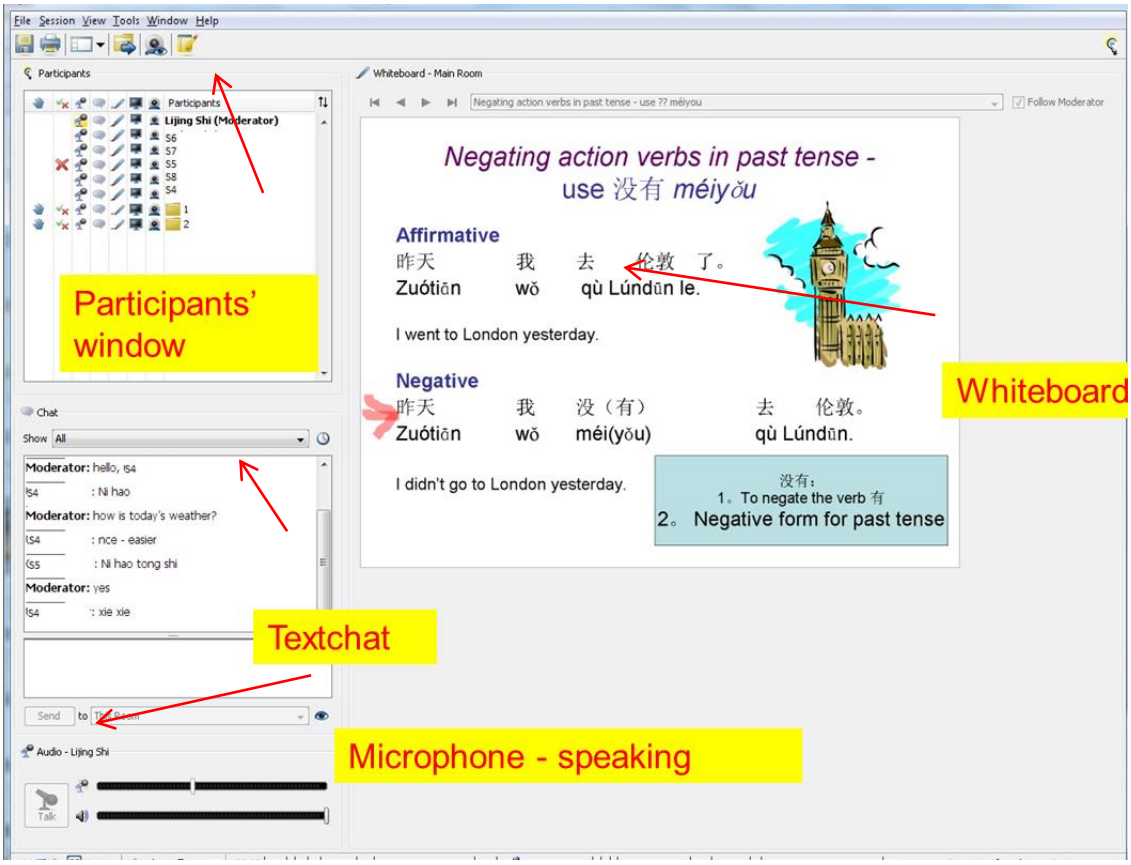
Following the methodology described above, we have carried out two studies to investigate language learners' and teachers' attention during synchronous online tutorials, using a Tobii eyetracker. The first study was conducted in 2012 with ten adult learners whose Chinese linguistic skills ranged from A1 to B1 on the Common European Frame of Reference (CEFR). This is the level that attracts most students and hence has the highest number of learners and teachers.

Before the eyetracking started, participants filled in a background questionnaire about their language and ICT skills. In the first eyetracking activity, each of them was asked to fill in the answer to reading comprehension questions based on a short Chinese text

with Pinyin transcription below. Characters, Pinyin and English questions were all presented in the same whiteboard area of an online video-conferencing interface, *Elluminate* (see Illustration 2, below).

In *Elluminate*, learning materials (text, pictures, movable objects) are made visible to everyone on the whiteboard. To speak and be heard by all other participants, users need to click a microphone button. They can also use a textchat function to communicate. The participant window on the left shows users' names with a list of icons which either indicate the activities they are doing (e.g. typing in the textchat) or their emotional responses (e.g. smiling or sad). They can use a 'Yes/No' button to cast votes, and activate a 'Raised-hand' icon if they wish to speak or ask a question.

Illustration 2: Elluminate interface with main areas labelled



In the second eyetracking activity, each of the learners participated in a short online tutorial with a teacher and three or four other learners via *Elluminate*. Based on our findings from a pilot study, we were aware that eyetracking generates a large amount of complex data and therefore decided to keep the interactions short to allow us to investigate more different learners. The interactive activity emulated a typical online tutorial requiring leaners to read, listen, speak or move objects on the screen in real time. Four weeks after the eyetracking experiments, each participant received an email asking them whether the eyetracking experience had had any impact on their Chinese learning. For more details on this study, please refer to Authors (2015).

In 2013-14, applying the same methodology, three teachers took part in our second study focusing on teachers' attention during online language tutorials. All of them were experienced language teachers teaching Chinese, French or German as a foreign language in a distance context at a British university. The German teacher had taught online for more than 10 years and was very familiar with the new online teaching platform that had replaced *Elluminate*. The Chinese teacher had started teaching Chinese online via *Elluminate* in 2008, but she had not used the current software. The French teacher had never taught online before this study but was familiar with both, *Elluminate* (see Illustration 2) and *Blackboard Collaborate*, the current software (see Illustration 1).

These three teachers were interviewed on their teaching beliefs and experiences, offline and online, before eyetracking. Then, they delivered a 20-minute online tutorial with four learners in a lab where their eye movements were tracked by Tobii. Subsequently, the teachers watched the gazeplot video with a researcher, recalling what had happened, explaining, commenting and reflecting on their teaching. Four weeks after the eyetracking experience, they received an email asking them to provide further thoughts on the effect of eyetracking on their thinking and teaching practice. In addition, the researchers also asked those learners who had participated in the three online tutorials to report any technical or linguistic problems to provide extra contextual information for the study.

3.2 Findings

3.2.1 The learner study:

Our investigation of students learning Chinese in online settings showed that all beginners or lower intermediate learners (A1 to A2 CEFR) used the Pinyin transcription to some extent if it is offered on screen. Only advanced learners relied solely on character recognition for comprehension checks. This can be evidenced through analysis and interpretation of the numerical information collected during the eyetracking. For the interpretation of learners' strategies and reasons for the use of Pinyin, however, we needed the additional information from the SR interviews. We garnered three different reasons for focussing on the Pinyin: some learners used it for comprehension if their recognition of Chinese characters was not well-developed, some checked Pinyin for confirmation although they generally had a good idea of the meaning of the characters; and finally, some learners used Pinyin simply for convenience or "because they were there", rather than employing a particular strategy.

In the analysis of the second part of our learner study, concerned with interactive online speaking, we found the areas of interest (AoIs) learners focused their gaze on of particular relevance. We divided the screen into three types of areas: content, technical and social. These labels are used as shortcuts, where "content" refers to language teaching content, "technical" describes areas where active use of a communication feature is possible, and "social" are those areas of the screen where information on other participants is displayed but which cannot be used actively. The content area, the main part of the whiteboard where the information, language help and language tasks are displayed (see Illustration 2), attracted the majority of fixations (70%); the technical area, e.g. the microphone button and textchat, features that participants had to use to communicate with others, attracted less than 10% of

attention. Our major finding, confirming the inherently social nature of online language tutorials, is the 20% of fixation directed to the social areas, features of the screen that provide information about other participants, e.g. their status of presence or absence, their names, emoticons they chose to display.

Again, confirmation of the importance of social presence indicators came from the SR interviews where learners mentioned the need to "see" who's there, find out who is speaking to them, etc. Mediation through technology that is capable of displaying this information in a timely and comprehensible manner proved an important factor in the understanding of online language learning our participants explained (see Authors, 2015).

3.2.2 The teacher study:

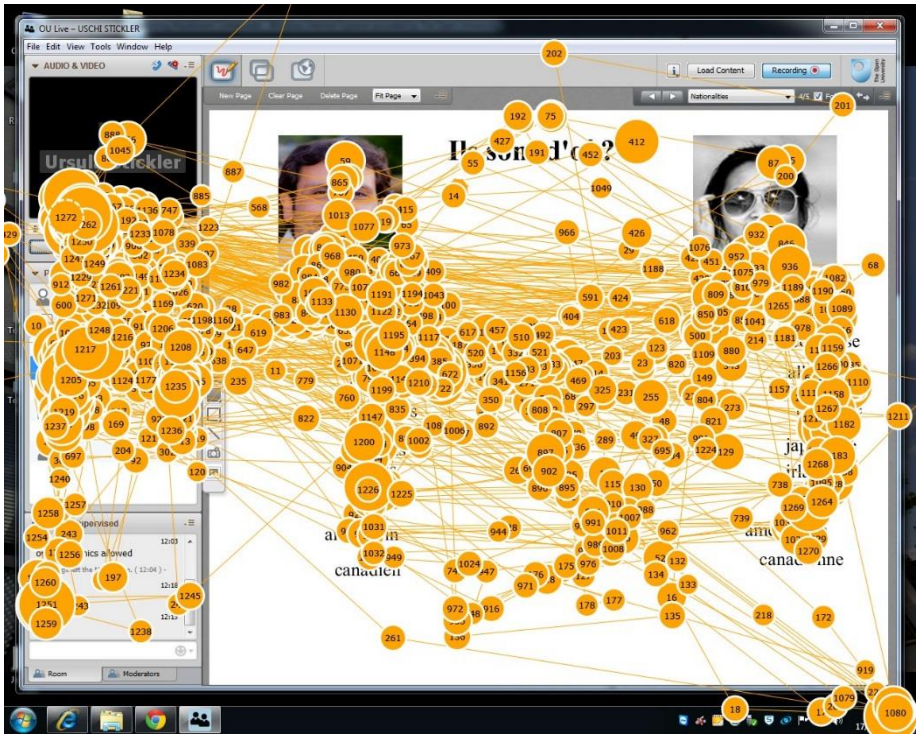
A fuller picture of online language teaching was revealed by the combination of quantitative and qualitative data produced in a teacher eyetracking study. Regarding teacher's attention during synchronous language teaching (SCMC), we discovered that teachers paid considerable attention to the social and technical areas of the screen in addition to their focus on teaching content.

Table 1: Three teachers' fixation ratio on different AoIs during online teaching

Areas of Interest (Aol)	Chinese Teacher *experienced online language teacher, unfamiliar with current software*	French Teacher *No online language teaching experience, familiar with current software*	*German Teacher* *experienced online language teacher, highly familiar with current software*
Content	54.58%	33%	63.45%
Social	25.86%	28%	24.68%
Technical	19.57%	39%	11.87%

Though this level of information can be derived at from simple numerical eyetracking data, employing a stimulated recall interview in the second step of the study moved teacher participants into the role of quasi co-researchers who gained an understanding of the information eyetracking representations such as gazeplot videos can provide and how to interpret them. The gazeplot video shows teachers their eye movements in detail and makes them aware of the complex multitasking they undertake while teaching online, thereby deepening their understanding, supporting their reflections, and guiding the questions and comments during the reflective interviews. As an illustration of the complexity of a teacher's tasks during online language teaching see illustration 3, a gazeplot image taken of a teacher's shift of attention focus during a short sequence in her tutorial.

Illustration 3: Gazeplot image of French teacher



SR data confirmed that unfamiliarity with the online teaching tool was the main reason for increased attention to technical areas (e.g. the microphone). The relative lack of visual clues pushed teachers to rely on the social areas of the screen to gather feedback from learners. As teachers need to pay attention to different areas of the screen, they felt that online teaching was more cognitively demanding ('intensive'). SR also reveals that teachers made conscious decision as to what content they paid closer attention to. For example, the French teacher speculated on her attention focus: "…you need to focus on the talk button and the, obviously, the participants window as you are interacting with them orally, you know the board there – ", recognizing the different needs of online vs. face-to-face teaching. The Chinese teacher's gaze focused on the Pinyin tone markers when she listened to learners repeating sentences shown on the screen; in the SR interview she reported that this attention focus was based on her believe that tones rather than pronunciation were the main speaking challenge for learners at this level.

In the SR sessions, all three teachers agreed that watching their own eye movements recorded during online tutorials was interesting and inspiring. The German teacher commented: "that's why it is so good to watch your own tutorial, the recordings we make often for the students,… but I find it is important that you as a teacher should watch it, so you reflect on it."

Watching their eye movements provided each teacher with solid ground to reflect on their teaching techniques. The German teacher identified her monitoring of the online classroom as a controlling function and felt that contrary to her conscious teaching style, her tutorial slipped into a teacher-centred fashion. Critically evaluating her own cognitive stress caused by the multitasking of online teaching, she also became aware of a possible 'cognitive overload' for students when considering how many tasks needed to be completed in a short timeframe. As a 'novice' online teacher, the French teacher frequently compared her online teaching experience with her classroom

practice. She first felt that the online tutorial was ‘restricted’, ‘less dynamic’, ‘slower’ compared to her usual teaching, but near the end of the session, she came to realise that the design of the online tasks should be adjusted (“I would need more props, I would have needed more screens”), and acknowledged that online teaching also offered a different way of teaching which could be more effective compared to classroom teaching.

The reflections of our teacher participants show their distinct approaches to teaching and learning; these are partly based on their understanding of how language is learned influenced by their pedagogies; partly on the affordances of the online environment that mediates communication; and partly on their institution’s preferred teaching approach and the training they have received in their place(s) of employment.

This study is only described here to a limited extend, presenting highlights relevant for the methodological argument. A fuller account will be published in due course (Authors, in preparation).

4 Methodology Discussion

With eyetracking generated information it is possible to draw certain conclusions about the attention focus of the user (Just & Carpenter, 1976). This step already implies interpretation based on certain hypotheses (“eye-mind-hypothesis”). In a psycholinguistic framework/study, data collected with the help of eyetracking can be used to form tentative explanations of users’ behaviour, it is one type of information that allows a researcher to look at what is going on “inside a learner’s head”. Within a paradigm that emphasises explanation over understanding and allows proof to be based on generalised statistical likelihood, the numerical data from eyetracking studies is sufficient to support the benefits of this method for advancing SLA. In his keynote speech at the BAAL-CUP symposium on eyetracking in online language learning (Authors, 2015a), Bryan Smith pointed out that eyetracking can be used to conduct exploratory research, to confirm other measures, to test assumptions of CMC, and to test SLA notions in CALL (Smith, 2015).

As mentioned above, we base our studies on sociocultural principles, and so our data collection does not end with the glimpse “inside the user’s head” interpreting what the eyetracking data offers us. We add retrospective and introspective methods into the mix to further our understanding of what is happening during an online learning episode. A qualitative research paradigm, emphasising understanding over explaining, does not rely solely on generalisability based on sufficient statistical data. Instead, it requires proof of a different kind to generate a convincing depth of description, proof that genuine empathy has been sought and the participant’s voice is respected alongside the researcher’s. In our unique mix of methods, SR interviews based on a replay of eyetracking data have been used to generate this depth.

SR is a method used to collect reliable self-reported data on participants’ thoughts during a recorded task or episode of language learning or teaching; it also is a useful tool to aid reflection and lead to deeper thinking (see e.g. Messmer, 2015). It offers participants a chance to present any strategies they are conscious of, confirm that their behaviour matches their own expectations or express their surprise about unexpected fixations. This allows for deeper thinking processes and a critical distance from the actual behaviours. As opposed to Think-Aloud-Protocols, SR is non-intrusive, the

interviews do not distract from the actual task (Gass & Mackey, 2000). For reading or writing tasks Think-Aloud-Protocols interfere less with the actual language learning, however, in our case (SCMC) where interactive speaking and listening play an important role, SR is more suitable for reflecting, as well as commenting on the tasks retrospectively.

As we have shown, eytracking is an up-to-date method for displaying visual data, furthermore, it can also be a valuable tool to engage participants in an interpretation of the findings. In addition to aiding memory by replaying events, eyetracking visualisation can add detail to our understanding of online behaviour, thereby making reflections potentially more powerful and more meaningful. In contrast to a simple audio or video replay, it can also accumulate the information, thus presenting a final record of major focal points or "heat areas" on a screen. ("I think I probably focus quite a lot on the technical part because this thing is pretty new …" Chinese teacher, reflection interview) This building up of a memory trace culminating in an interpretative image is not possible with the fleeting traces provided by other replay methods.

Within a sociocultural context our two exemplary studies show how appropriating eyetracking, which is often used for HCI or psycholinguistic studies, and combining it with other, qualitative methods can potentially shift attention-focus research from a cognitive perspective to a learner-centred, hermeneutic approach. The examples from our learner study show how online language learning and teaching spaces are mediated by technology as well as by the second or foreign language. The reflections generated by the stimulated recall interviews in our teacher study add the dimension of an online teaching culture as mediating factor.

Research, in our context, is not just a means to generate knowledge but also a responsibility. In addition to its qualitative stance, our project is also pedagogical: we want to improve online language learning and teaching and make it more beneficial for learners and more satisfying for teachers. This can be seen in parallel to a user-centred approach in HCI research. For this purpose the potentially reflective aspect of stimulated recall has been used in our mix of methods. As Levy and Kennedy claim, we "…have reached a point where we recognize that learners need reflective activities to develop language awareness, as well as productive activities, in order to become effective and autonomous learners." (Levy & Kennedy, 2004, p. 53) For the adult learners in our study, seeing where their attention is focused has provided additional insights and has led to deep speculation and reflection on learning strategies and the reasons for using input. ("I do remember being panicked because there are some clues and if I don't pick up on the clues, I might pick up afterwards but I didn't recognize the Chinese characters." Jie Ni SR interview). Thus, stimulated recall based on gazeplot videos has proven effective in raising learners' awareness of the strategies they employ in online learning and has led them to reconsider their approaches.

For eyetracking studies in a socio-cultural framework this additional perspective is indispensable, and a combination of introspective and external methods will be requisite for any future study claiming ecological validity. The user's own understanding of their attention and conscious or pre-conscious actions is necessary to support any claims of interpreting the meaning of online interaction. Lacking this perspective, the study remains on a surface level of linking gaze focus tentatively to attention without viewing the wider context of learning and teaching and without the prospect of contributing to a deeper understanding of the field.

For teachers, the experience of reflecting back on their teaching is not unique; the "reflective practitioner" (Schön, 1987) uses the cycle of action and reflection continually for professional growth and continuing professional development. Messmer (2015) uses stimulated recall to access the deeper thinking of teachers during their face-to-face classroom practice. In the area of CALL teaching, Cutrim Schmid (2011) promulgates the idea of using video stimulated reflection on the use of interactive whiteboards in face-to-face classrooms. However, none of these studies are transferable to online language teaching. Eyetracking data in the way we propose to use it, is a novel form of information supporting deep reflection in teachers by offering enhanced information (gaze focus), by concentrating recall and reflection on certain areas of attention focus, and by adding a cumulative perspective on sequences of online interactions (heat maps).

Even the most experienced online teacher we interviewed was impressed by the richness of information provided through this method. And all teachers used the study as a chance for reflection. As Messmer found out, SR can lead to teachers becoming aware of the basis for decisions that influenced their behaviour (Messmer, 2015, n.p. para 16).

To answer our research questions, we can confirm that, firstly, by investigating tasks and interactions in online tutorials with eyetracking we can find out how these tasks are actually used and speculate about cognitive processes (see Leow et al., 2013), e.g. in reading comprehension (Authors, 2015b). With the stimulated recall interpretations we can also confirm the conscious strategies and intentions in play. They bring to the fore reflections based on an awareness participants gain from viewing a gazeplot video that shows in detail where their (attention) focus was at any particular time in the online interaction. Their reflections are by no means a direct confirmation of what an external viewer would see, they allow the additional perspective of the "insider", the actual user and agent, to be considered as part of the rich picture of an online learning or teaching event.

Secondly, through our mix of methods participants can benefit directly by becoming more informed and more reflective learners and teachers. We use the eyetracking videos to support reflectivity, a focus on one's own learning and teaching that could not be stimulated to such a depth with less detailed materials. By bringing in the voices of our participants to confirm our findings and to enhance their own reflectivity as learners and teachers in online environments, we aim to make research, as Onwuegbuzie and Frels (2013) suggest, a more democratic and equal process.

And thirdly, our unique combination of methods, making use of technology-supported investigation methods and reflectivity-enhancing interviewing formats, is suitable for a framework that sees learning as an inherently social process and can significantly enhance our understanding of the different forms of mediation underpinning online language learning and teaching from a socio-cultural perspective. We can see the insider and the outsider view of online language learning and teaching, and we understand our own "learning" or knowledge generation as intertwined with our participants' contributions and reflections; furthering our own search for a suitable mix of methods to investigate online language learning.

5 Conclusion and further studies

This paper is framed in sociocultural theory, an approach that posits that learning takes place in the interaction of the individual with its environment, supported by factors that support or "scaffold" steps of learning. Within this framework human agency is neither determined by our sociocultural environment and history nor entirely controlled by individual "will" or deliberation; instead actions are "mediated" (Wertsch 1994).

This theoretical position precludes a simplistic epistemology of cause and effect and makes it desirable to approach learning from different perspectives, as a) an observable behaviour, b) a deliberate action on the part of the learner, and c) as a socioculturally determined interaction between learners and teachers in designated spaces for learning. Based on this, we chose a mix of methods to investigate language learning and teaching in online synchronous multimodal environments.

Apart from the pilot studies necessary to refine our methods, two studies were carefully designed and conducted to exemplify the power of this new methodological approach and prove that our innovative combination of methods can produce relevant results. We have shown how technology mediates the online learning and how learners make use of the affordances of the online environment. We have brought to light strategies employed by language learners. Giving a voice to our participants through stimulated recall, and ensuring that they benefit from an enhanced reflectivity on their learning through on-going discussions and a follow-up questionnaire as part of our research project has changed the research perspective from an outsider view on cognitive processes to an insider-outsider perspective on sociocultural learning events online.

Although these initial studies are sufficient proof that combining methods taken from different areas of the interdisciplinary field that comprises CALL research is fruitful and worthwhile, further studies would be of interest. For example, the specific teaching skills employed by the online language teachers necessitate investigation; "cultures of teaching" related to cultures of origin, training, and residence of different language teachers are another field that could lead to theoretical insights and valuable pedagogic conclusions. A comparison of teachers' and learners' ideas about pedagogy and online learning can be stimulated by applying our combined methodology in situations where the educational background and training of participants is different. Another avenue of research could be the delayed reflection of teachers and the influence their eyetracking experience had on their online presence and behaviour in future tutorial. Currently, this longitudinal aspect is still missing in our own research. An area that has shown to be of particular importance in online teaching events is the use and interpretation of silences in online language classrooms; this also merits further investigation. In a more practical vein, more work is needed to establish how eyetracking can be used in teacher training and self-reflective practice.

Some limitations of our methodology are of a very practical nature: it is still a technology with limited availability. For our studies we could only track one person at a time, and due to the fixed nature of our eyetracker we had to collect data in a laboratory setting. These issues might have influenced the behaviours of participants (Authors & colleagues 2015). For qualitative studies a small sample size should not be detrimental, however, some larger scale studies are needed to create a baseline of, for example, linguistic skills, reading levels, etc. These eyetracking studies could become a valuable frame of reference or backdrop for studies following a mixed or qualitative methodology.

In this methodologically focused paper we have shown how a particular combination of methods used in a particular theoretical framework can move our understanding of online language learning and teaching forward, potentially challenging more traditional approaches that would not have been able to uncover the same rich, multifaceted findings. We have also implicitly shown how important it is for the researcher to keep in mind at all times the underlying epistemology and ontological stance to do justice to the research process and help to progress pedagogy and learning.

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[i] When investigating screens that remain static during the entire eyetracking process, creating heatmaps is relatively simple. In cases of dynamic screens, where the properties change and attention focus needs to be matched to the different visual properties of the screen, cummulative measures are more complex as the video needs to be cut into scenes and a series of heatmaps or gazeplot images need to be created.

[ii] Another valid method currently used is video screen capture, sometimes combined with keystroke capture (see e.g. Smith 2009).