Measuring Lexical Alignment During L2 Chat Interaction: An Eye Tracking Study

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Abstract

Learner interaction via written synchronous computer mediated communication (SCMC) in their second language (L2) may be facilitative of L2 development (Smith, 2012), as such interaction heightens the salience of specific aspects of the input learners receive, thus increasing the likelihood that aspects of this input are noticed (Schmidt, 2001). This heightened salience of input is afforded by the permanence of the written message on the screen, which allows learners more time for processing incoming messages and monitoring their own output. This exploratory study aims at establishing whether this heightened salience during SCMC supports lexical alignment. Using eye tracking technology, we explore what L2 users seem to notice, attend to and align with in the linguistic input from their L2 interlocutor.

Six advanced L2 users of English (TESOL MA students) interacted in dyads via SCMC over six-weeks. They chatted each week with another student and discussed how to finish a partially completed academic abstract. Participants' task performances were screen-recorded and their eye movements captured. Corpus methods were used to analyze chat logs for lexical overlap of three or more consecutive words (n-grams). Potential sources for lexical alignment were then marked as areas of interest (AoI's) and various eye-gaze measures were calculated for these AoI's and for baseline text. Comparisons between eye-gaze measures for potentially aligned text and baseline text were made to identify those n-

grams that received more visual attention than baseline text (i.e., noticed text). Analysis revealed that a limited amount of potentially aligned received heightened overt visual attention.

We argue that most instances of lexical overlap were likely attributable to processes other than strategic alignment. Qualitative explorations show that SCMC partners do make use of one another's input during task-based SCMC in a way that manifests in their written output. However, it is much less than chat transcripts may suggest.

Introduction

Written synchronous computer mediated communication (SCMC or text chat) is a pervasive means of communication in our globalized society, with many writing messages in the L2. From a Second Language Acquisition (SLA) perspective, text chat interaction has been argued to be potentially facilitative of second language (L2) development. As Smith (2005) claims, written SCMC is "the ideal medium for students to benefit from interaction" (p. 34) because it affords greater opportunity to attend to and reflect on the content and form of incoming (as well as their own) messages.

There is a growing body of research exploring the questions of how and why SCMC might support L2 learning (cf. Kern, Ware, & Warschauer, 2008; Chapelle 2009; Sauro 2011; Ziegler 2016). One recurring argument is that text-based SCMC increases "the visual saliency of certain forms […] and the enduring as opposed to ephemeral nature of the turns" (Sauro, 2009, p. 96). Increased salience follows from the fact that during SCMC interlocutors have more time to process incoming messages, review earlier turns in the conversation and monitor and self-correct their own output before hitting the enter (return) key. In addition, the salience of input and output, which is afforded by the permanence of the written message on

the screen, has been said to contribute to noticing of form and meaning during text chat (Schmidt, 2001; Smith, 2005).

The present study draws on this idea of increased salience during SCMC and explores how the specific modality of text chat affects interactional alignment between peers chatting in L2 English. To define alignment, Costa, Pickering, and Sorace (2008, p.530) explain that "interlocutors construct mental models of the situation under discussion, and successful dialogue occurs when these situation models become aligned. [..] In the interactive-alignment account, such alignment of situation models is linked to the tendency for interlocutors to repeat each other's choices at many different linguistic levels, such as words, sounds, and grammar." The authors distinguish the mental alignment from the surface phenomenon of, for example, repeating the same words; this is called 'lexical entrainment'. Entrainment in turn is distinguished from the underlying psycholinguistic mechanism, that is, priming, which refers to a speaker's repeated production of a previously spoken or heard structure across successive utterances Bock (1995). To avoid terminological confusion in this chapter, we will consistently use 'alignment' to encompass all three aspects of the phenomenon under investigation, knowing that this represents a simplification. That is, we talk about alignment in all three cases, (a) when we refer to convergence of the mental model, that (b) manifests itself as lexical entrainment and (c) is likely to be caused by the psycholinguistic mechanism of priming (see Costa et al., 2008, p. 531, for a discussion of the three concepts and the fact that alignment is "often loosely used to refer to observable behaviour"). In the following, we will review literature covering all these different angles given that they add to the understanding of the phenomenon under investigation in the present study.

The aim of the work presented in this chapter is to investigate instances of lexical alignment (or overlap) between chat interactants and use eye-tracking methodology to establish whether the repetition of exact lexical items of a partner's earlier utterance goes

hand-in-hand with increased overt attention (i.e., higher fixation duration and fixation counts). This study is the first of its kind to explore alignment in SCMC using eye-tracking methodology. Apart from our theoretical goal to investigate whether L2 interactional alignment takes place in an SCMC context, we also aim at advancing the field by our methodological contribution on how to apply eye-tracking technology in SCMC research.

Salience in SLA and SCMC

One of the first studies that coined the notion of salience in SLA research was Bardovi-Harlig (1987) who defined it as the "availability of data" (p. 401). More recent work found that salience is based on perceptual physical features like stress or position in a phrase as well as categories affecting processing such as frequency and complexity of a structure (Ellis, 2006; Goldschneider & DeKeyser, 2001). Goldschneider and DeKeyser (2001) define salience as "how easy it is to hear or perceive a given structure" (p. 22). From an SLA perspective, salience has long been acknowledged as an important factor (Gass, 1988) that explains why some input becomes intake while other input remains unnoticed and therefore does not easily become integrated into the L2 learner's system. Salience is strongly related to noticing and attention, building on the idea that the more salient a feature is, the more likely it is to attract attention and be noticed. Attention and noticing are key processes that support L2 learning. Schmidt's (1990) original strong version of the noticing hypothesis sees noticing, that is, "the conscious apprehension and awareness of input" (Schmidt, 2001, p. 26), as a necessary and sufficient condition for learning to happen. Later, in the weaker version Schmidt (1994) assigns noticing only a facilitative role for SLA. Whether awareness is needed for learning or not remains a topic of debate (Ellis, 2006; Robinson, 1995; Tomlin & Villa, 1994). Most research seems to agree, however, that selective attention (with or without

awareness) is needed for successful SLA and selective attention is more likely when a language feature is salient.

From a language pedagogic perspective, it has been claimed that the distinct characteristics of written SCMC increase the salience of the linguistic input during L2 chat thereby guiding a learner's attention to linguistic form and supporting uptake and intake of L2 forms (Smith, 2005). First, most people type more slowly than they speak, which results in a slower pace of turn-taking during SCMC than in spoken interaction (Gurzynski-Weiss & Baralt, 2015), resulting in what Beauvois (1992) refers to it as a "conversation in slow motion" (p. 455). Second, the output of a chat conversation remains visible on the screen, which also increases the potential salience of lexical items and grammatical structures. This "permanence" allows L2 users to re-read and re-visit information they might have missed or misunderstood at first instance or to get inspiration for their own contributions and, for example, appropriate parts their partner's language. In this sense, SCMC contrasts strongly with ephemeral spoken interaction where everything said is gone within seconds, or as soon as it leaves working memory. Third, SCMC allows L2 learners to monitor and edit their own writing before they transmit their message by hitting the enter key. Fourth, because intonation, gesture and facial expressions, that often guide oral interaction, are absent, SCMC pushes L2 learners to use language (e.g., pragma-linguistic forms) to express themselves (Sykes, 2005) as they encounter (and arguably) resolve gaps between what they want to say and what they are able to say (Swain, 2005).

Because of these distinct features of text-based chat, Sauro (2009, p. 96) argues that text chat "holds particular promise for the learning of especially complex or low salient forms" because the modality has the potential of increasing salience. As such, SCMC could be used as a tool in L2 pedagogy as it implicitly guides attention to form. This is in accordance with Schmidt (2001) who stated that intentionally focusing attention (e.g., on

non-salient forms), is an essential prerequisite for learning to happen. Empirical evidence for these claims comes from Lai and Zhao (2006) who did find more noticing during written SCMC than in oral interactions. Immediately relevant to the present study is that the characteristics of written SCMC suggest that it could be an ideal context for alignment where salience of and attention to a form might play a major role in eliciting aligned language. The following section will explain why alignment in the L2 is a phenomenon worth exploring.

Alignment: L1 and L2 perspectives

Over the years, different scholarly fields have used a variety of terms to refer to the observational linguistic "unintentional and pragmatically unmotivated tendency to repeat the general [syntactic] pattern of an utterance" (Bock & Griffin, 2000, p. 177). In psycholinguistics, where the focus lies on investigating the underlying processing mechanism, researchers tend to use 'priming' or 'persistence' (Pickering & Ferreira, 2008). Socio-cultural scholars tend to refer to 'alignment', 'accommodation', 'convergence' or just 'repetition' (Atkinson et al., 2007; Tannen, 1987) as they investigate the phenomenon as an aspect of successful dialogue (Costa et al., 2008). In this chapter we draw on literature from these different fields and have chosen to use 'alignment' in order to avoid terminological confusion when we address the same basic phenomenon (i.e., the inclination of interlocutors to adopt each other's language). We chose 'alignment' because, firstly, it seems to encompass all levels of the phenomenon: the mental alignment of situational models, the linguistic manifestation of it (also called 'entrainment') as well as the underlying psycholinguistic mechanism of 'priming'. Secondly, alignment better reflects the context of the current investigation (i.e., naturally occurring repetition of linguistic forms in authentic conversation) in contrast to 'priming,' which seems to be most often used in situations where an intentional (experimental or pedagogical) design is aimed at eliciting lexical or structural repetition (cf.

Branigan et al., 2007). Please note that, when reviewing earlier work, we will use the term that is used by the respective authors.

Why do conversational partners align? According to Branigan et al. (2007) successful dialogue is the product of "collaborative effort" (p. 165) as interlocutors "come to share many aspects of their representations of the situation under discussion" (p.164) and alignment of their mental models of the situation happens. Such situational alignment is known to influence linguistic alignment and vice versa (Pickering & Garrod, 2004). That is to say, over the course of authentic interaction partners are likely to re-use each other's language patterns (Trofimovich, 2013) as they work towards a common ground of their mental model (Horton, 2005). In their comprehensive review of earlier work on alignment, Pickering and Ferreira (2008) state that alignment affects all levels of linguistic processing (i.e., morpho-syntactic, lexico-semantic, phonological and pragmatic choices of production and perception). To give an example: when speaker A uses the sentence '*The chair was put next to the table.*' the interactional partner B will subsequently process words like *CABLE* and *DESK* faster and with greater ease because of the phonological and semantic overlap between these words and the prime *TABLE*. In addition, partner B will be more likely to also use passive voice in her following utterances because the passive structure was activated.

Extensive lab-based psycholinguistic research suggests that syntactic alignment, in particular, is based on automatic and implicit processes that take place largely beyond the awareness and intentions of language users (Costa et al., 2008; Pickering & Branigan 1999; Pickering & Ferreira, 2008) while lexico-semantic choices could be a result of more conscious decisions to maximize understanding (cf. Branigan et al., 2007).

In L2 pedagogy, empirical research has shown priming (as a pedagogical tool to elicit aligned language) to successfully trigger the use of a variety of structures, such as double-dative constructions (McDonough 2006), passive voice (Kim & McDonough 2008), question

formation (McDonough & Mackey 2006, McDonough & Kim 2009, McDonough & Chaikitmongkol 2010, McDonough & DeVleeschauwer 2012), noun and verb morphology (Marsden, Altmann, & St Claire 2013, McDonough & Fulga 2015), pronunciation (Trofimovich 2013; Trofimovich, McDonough, & Neumann, 2013) and others (see Trofimovich & McDonough's 2011 edited collection). Even though this research as a whole tentatively supports the occurrence of primed production, effects are often small and the influence on different target structures is quite variable. For example, McDonough (2006) found evidence for primed production of prepositions but not of double object dative constructions. Similarly, Shin and Christianson (2012), who combined priming and explicit instruction, did find priming-plus-explicit-instruction to elicit enhanced production of double datives in the short term but priming-only showed larger long-term effects. For phrasal verbs the opposite picture emerged. Boston (2009) used pre-task priming to elicit passive voice and found no statistical differences between the experimental and control groups. As acknowledged by McDonough and de Vleeschauwer (2012) prompt frequency and individual differences may play a role. Similarly, context and interlocutor (e.g., interacting with a scripted L1 speaker versus classroom based peer interaction) seem to influence the success of priming (Kim & McDonough, 2008).

In contrast to L1 processes, there is some evidence that alignment in an L2 may not be entirely beyond awareness. For example, findings by Marsden et al. (2013) have shown that focusing an L2 user's attention to the morphological structure of a prime increases the size of subsequent processing gains attributed to priming. From a theoretical point of view Costa et al. (2008) further explain that in L2 conversation '[…] the degree of shared knowledge between the interlocutors may not be enough for automatic linguistic alignment to function in the same way it does when the two interlocutors are native speakers' (p. 537). In addition, alignment is thought to be resource-free and automatic between-speaker adaptive behavior

(Pickering & Garrod, 2004), which is not something we associate with L2 processing, in particular, with regard to processes of formulation (lexical retrieval, morpho-syntactic encoding) at a beginner or intermediate level (de Bot, 1992). Moreover, L2 speakers may not be able to align to a structure or word they lack in their interlanguage system. Costa et al. (2008) also point out that L2 learners may actively suppress alignment because they want to avoid a form they feel insecure about. Finally, processing limitations may interfere with alignment, either because the L1 of an L2 speaker is highly activated and L1 transfer overrules automatic alignment in the L2 or due to the fact that slow speech rates, activated structures and items have already decayed in working memory by the time an interactant reaches a possible context for alignment.

Whether alignment in an L2 is an implicit and automatic process or whether it is mediated by conscious strategic behavior of second language users is an empirical question. Moreover, even though there is a body of SLA research that provides evidence that priming is the underlying mechanism of alignment, this earlier work has looked only at spoken interaction. The aim of the present chapter is to explore alignment in the context of written synchronous computer-mediated communication (SCMC or text chat).

Alignment in SCMC

So far, very little research has looked at alignment in an SCMC context. Reviewing L1-L2 text-chat interactions from a socio-cultural perspective, Uzum (2010) concludes that by scrolling back and forth through earlier statements, "participants aligned their language use and choice of grammatical structure and words to that of their partners." (p.144). Michel (in press) performed an SCMC study in a high-school classroom among British girls learning German. Her chat-log analyses of the peer interaction revealed several instances of alignment at the lexical and syntactic level. Accompanying focus-group interviews supported these

findings, as the L2 learners reported taking their partner's writing as a model for their own chat contributions. In a corpus-based study comparing L1 interactions to elicited L2 interactions in a classroom, Collentine and Collentine (2013) explored 'convergence'. Their study targeting the use of subjunctive mood in Spanish showed that L2 peers displayed even greater convergence than L1-L1-partners. Finally, the authors ask about the use of "structural convergence as a learning mechanism" in an SCMC environment (p.185). The present study pursues exactly this goal, that is, to examine aligned production during written SCMC in an instructed setting. At this point, our aim is not so much to explore whether learning might occur as a result of alignment. In the first place, we wish to examine whether alignment during L2 SCMC is related to overt attention as a prerequisite for noticing and eventually learning. The novelty of this study lies not least in its methodological approach, which includes eye-gaze measurement.

Eye-tracking SCMC

Until recently (and continuing on today, unfortunately) many SCMC studies relied solely on chat transcript logs -- a very static approach to explaining a dynamic process (e.g., O'Rourke, 2008; Smith, 2010). O'Rourke (2008) suggests that reliance on such 'impoverished data' is quite dangerous as researchers may be quick to assume that because a particular tool has certain affordances, that learners actually make use of these affordances. Some studies have now started to use screen-recording methodology to capture the dynamicity of the process (Gurzynski-Weiss & Baralt, 2015; Sauro & Smith, 2010).

Smith (2010, 2012) argued that on top of screen-capturing, eye-gaze data may help to inform some of the contentious debates in SLA (e.g., is noticing a prerequisite for learning?) and that gaze tracking may be employed as a robust supplemental measure when triangulating findings based on other established methodologies (e.g., stimulated recall and

think-alouds). Indeed, as pointed out by Godfroid, Housen, and Boers (2010), eye tracking as a data collection technique seems less likely than, say, think aloud to interfere with the participants' cognitive processing (see also Godfroid & Spino, 2015).

For example, Smith (2010) showed that learners noticed about 60% of the intensive recasts they received. He found that lexical recasts were much easier than grammatical recasts for students to notice, retain, and accurately produce on a written post-test. Of particular relevance to the current study, learners were also better able to productively use the recast targets during subsequent chat interactions. Smith (2012) found eye tracking to be a reliable technique for measuring what learners attend to (along with stimulated recall) in written corrective feedback from a native speaker interlocutor. Semantic and syntactic targets were more easily noticed by learners than were morphological targets. Smith and Renaud's (2013) learners focused on about 75% of teacher recasts. Of these recasts, up to one-third were retained as measured by a delayed post-test one week later. A suggestive positive effect was established for fixation count (number of fixations on a target) and post-test success, while total fixation duration and post-test success were not related. A small-scale study on learner-teacher interactions by Örnberg Berglund (2012, 2013) revealed that all of the teacher's comments were seemingly noticed, though at times long after they were posted (up to several minutes later). In her study, writers focused on their own writing and read the teacher's contributions only once they had finished with their own composition and had hit the enter key. This confirms O'Rourke's (2012) pattern of "post-send monitoring" during written SCMC and suggests that some learners do not engage in two other common patterns: "simultaneous monitoring" or "pre-send monitoring."

The question of how salience affects L2 learning during text-based SCMC is just one of the open questions regarding attentional processes in this medium. Eye-tracking methodology can be a fruitful approach to tap into these issues.

The present study

In the present study we investigate lexical alignment by L2 peers during task-based SCMC performance. Besides our aim to increase our understanding of whether alignment takes place during L2 peer interaction via SCMC, we also wish to make a methodological contribution. By broadening our approaches to measuring eye-gaze behavior in SCMC research we address the question of how we can code and analyze linguistic content and targets that are creative and dynamic in nature.

Research Questions

RQ1:   To what extent do L2 peers align at the lexical level when interacting via text-based SCMC during task-based interaction?

RQ2:   Can eye-tracking technology help us disentangle explicit, overt attention to an interlocutor's output from implicit processes of aligned production?

Method and Design

Participants

Given the study's explorative nature, only six participants were recruited for this study (Tables, Excerpts and Figures
Tables

Table 1 summarizes their characteristics). All participants were L2 users of English with various L1 backgrounds and were studying in an MA TESOL or Applied Linguistics program in the UK or the US. They had a mean age of 26.3 years (*SD*=5.0) and had studied English for an average of 11.1 years (*SD*=3.3). At the time of the study they had resided in an English

speaking country for a mean of 5.7 months (*SD*=4.6). Their self-rated writing proficiency in English was at B2 to C1 of the Common European Framework of Reference for Languages (CEFR; Council of Europe, 2001), which was supported by their scores at the higher end of a general test of English proficiency (http://www.transparent.com/learn-english/proficiency-test.html). Students signed up on a voluntary basis.

Please put TABLE 1 HERE

Material

Students were paired up – one in the UK and one in the US, P1 and P6; P2 and P5; P3 and P4 – for a total of seven chat sessions that each lasted 45 minutes. The first session was dedicated to getting to know each other and to familiarize themselves with the chat environment. For this purpose, partners used the written chat function in Skype to ask and answer a couple of questions targeting their individual characteristics and knowledge of CALL (see Appendix A). In the following weeks, students participated in six experimental sessions. In each session they received an abstract from a published CALL study that was divided into three parts (beginning, middle, ending), two parts of which were available in full text. The third part was presented as a bullet-point summary (cf., Figure 1). Their task was to construct a full version of the bulleted section so that the abstract was complete.

Please put FIGURE 1 HERE

Participants were asked to first discuss with each other how to reconstruct the bullet-point text during 20 minutes of chat interaction. Afterwards, as a post-task they had 15

minutes' to write their individual reconstruction. Each week students worked on a different study and abstract. The experimental sessions focused on the beginning (session 1, 2), middle (session 3, 4) and ending (session 5, 6) parts of the abstract respectively (cf., Figure 2**Error! Reference source not found.**).

In order to ensure the content of the tasks was relevant yet largely unfamiliar to the participants, abstracts for all tasks were all taken from a major CALL journal. We also included the post-task reconstruction activity in order to frame their chat interaction as a meaningful preparation for the individual writing task.

Please put FIGURE 2 HERE

Apparatus

Eye-tracking and screen recording

Eye movements of the UK participants were recorded with a Tobii TX300 integrated eye-tracking system using dark pupil tracking (sampling rate of 300Hz) on a 23" TFT screen. The experiment was presented with Tobii Studio 3.0.9 software (Tobii Technology, n.d.) and standardized criteria for the procedure (e.g., 9-point calibration of each eye) and position of the participants (e.g., at ca. 60cm distance from screen) were followed.

Eye movements of the US participants were recorded with a portable TM3 eye tracker (sampling rate 60Hz) from EyeTech Digital Systems using Gaze Tracker 10.0 Data analysis software. The TM3 was attached to a 21" monitor. This system also uses dark pupil, single or binocular tracking. Nine-point calibration was used with a 60cm operating distance.

We used the in-built screen recording feature of the eye-tracking software to capture the entire experimental session. In addition to allowing a playback of each learner's eye-gaze

during the entire recording, the software records the location and duration of each eye fixation (among many other aspects of learners 'eye-gaze).

Chat interactions

Student partners used the written chat function of Skype to interact with one another. This program allowed us to set the font size to 24 so there would be enough space between words and lines to pin-point eye-gaze behavior. Chat partners each received an anonymous Skype name and login. During the testing sessions, the task and chat window were presented side by side on the same screen (cf. Figure 3). For the post-task abstract reconstruction students worked individually in MS Word.

Procedure

Participants were tested during individual sessions at each end (UK and US) in the eye-tracking lab. Because of the time difference between the two testing locations, these were scheduled between 5 and 7 pm (UK) and 10 am and 12 noon (US) for seven weeks in a row on Wednesdays. Before the students arrived, the researchers had established Skype contact with the respective user names. Upon arrival, participants were seated at approximately 60 cm from the screen in a comfortable position that allowed them to use the keyboard and the mouse. After calibration, they spent about 2 minutes reading the instructions and task sheet. They then signaled to their chat partner that they were ready and were allowed 20 minutes to discuss the content of the bullet-point summary of the abstract for the specific week.

Please put FIGURE 3 HERE

Coding and analysis

The coding and analysis of the data consisted of three steps: (a) identifying lexical overlap of 3- to 10-multi-word-units between the two chat partners; (b) manual coding of these possible sources for alignment in the eye-tracking data as well of baseline gaze behavior; (c) qualitative and quantitative analyses comparing baseline data to gaze behavior on possible primes. The following sections provide details on each of these steps.

N-gram analysis to identify lexical overlap

Chat-logs for each participant pair and each task were copied from Skype into plain text documents. An automatic spelling checker identified unknown words (e.g., vocabulrary) and manual corrections were made of typos (e.g., "vocabulrary" to "vocabulary"). Using R, each chat partner's corrected contributions were then divided into multi-word units of 3 to 10 words (n-grams) and a comparison between the two partner's n-gram lists identified exact lexical overlap.[1] Restricting ourselves to 3-to-10 grams allowed us to work with a meaningful set of target constructions. That is, while 2-grams could consist of function words only (e.g., "of the") 3-grams and larger units would always include at least one content word, which was seen as the basis of lexical alignment. A further benefit of this restriction was that the resulting set of target constructions was of a manageable size to allow manual coding of the eye-gaze data. We named the extracted n-grams 'possible source of lexical alignment' (*PSLA*). Those identified *PSLA*s were then located in the chat logs and we determined which chat partner had used the n-gram first (see example in Table 2).

Please put TABLE 2 HERE

Manual coding of eye-gaze data

Using the eye-tracking software we replayed the chat interactions until the *PSLA* (as written by learner A) appeared on the screen of learner B. For example, the 3-gram 'of the study' was identified as a *PSLA* in the interaction between participant 2 and 5. Participant 2 (learner A) used it first. In the screen recording of participant 5 (learner B), we found the time stamp when 'of the study' appeared in learner B's chat window, that is, as soon as participant 2 had finished writing this unit and had hit the enter key. We drew an Area of Interest (*AoI*) around this *PSLA*. An *AoI* is a type of box that the eye-tracking software uses to keep track of eye-gaze behavior in a specific location on the screen. As soon as one of the partners hit the enter key again, the target would move up to its new position in the chatlog window. The original *AoI* was deactivated and a new *AoI* was drawn at the new location. This procedure was repeated until the *PSLA* was off the screen or until the participant (learner B in this case) used the same lexical N-gram productively, whichever came first. Finally, all *AoI*s that belonged to the same *PSLA* (e.g., all for 'of the study') were grouped, and the statistics tools in the respective software packages were used to retrieve the Total Fixation Duration and Fixation Count for each group of *AoI*s corresponding to one specific *PSLA*.

To enable a comparison with normal gaze behavior during chat interactions, a recording of one full chat session for each participant was used to establish a baseline (Godfroid, Boers, & Housen, 2013). In each case, participants served as their own control. This time, *AoI*s around each complete turn of the chat partner were drawn following the process described above. Total Fixation Duration and Fixation Count metrics for each baseline turn were retrieved from the software.

Finally, metrics were normalized for the size of each *AoI*. That is, as *AoI*s were of different

length, such as 'what do you think' (17 characters including 3 spaces) versus 'of the study' (12 characters including 2 spaces), it was expected that larger *AoI*s would receive longer and more fixations. Therefore, we standardized our measures by establishing the number of characters including spaces for each *AoI* and dividing the gaze metrics by this number (cf., Indrarathne & Kormos, 2016[3]).

Results

Qualitative examples

When qualitatively reviewing eye-gaze data of our SCMC participants we found examples of overt attention to lexically aligned text, that is, instances that suggested a participant was drawing on the input of their chat partner when writing their own contribution. We found these instances concerning single words and multi-word units as well as reuse of structural patterns. For example, in the first task participant 2 and 5 discussed the use of vocabulary. Participant 5 consistently uses 'vocab' and provides three models over a course of several turns (40, 41 and 48), which eventually is picked up on by participant 2, who uses 'vocab' in turn 60 (cf. Excerpt 1).

Please put Excerpt 1 HERE

Exploring the eye-gazes on this specific instance indeed showed that participant 2 fixated 17 times on P5's 'vocab' during a total of 3.645 seconds.

Similarly, we established overt attention to larger units of overlapping text between partners. For example, Figure 4 shows the eye-gaze of participant 1 conversing with participant 4 during the fourth experimental session. On the left, we see attention to the multi-

word unit 'to find the groups' participant 6 wrote at time 7:24pm, while participant 1 is writing the same words herself at 7:25pm, as demonstrated by the screen shot on the right.

Please put Figure 4 HERE

Finally, at a more abstract level eye-gazes also attested overt attention to re-produced structures. As shown in Figure 5 where participant 3 and 4 interact we see repeated eye-gazes of participant 3 on the expression 'you want to add to our discussion' contributed by participant 4 during the third experimental chat session. A few turns later, participant 3 writes 'we have to add this in our middle', which has the same underlying syntactic structure 'SUBJ VERB$_{finite}$ *to add* PREP *our* OBJ' including partial lexical overlap of 'to add' and 'our'.

While these kinds of examples were found in all participants' recordings, one aim of this study was to evaluate just how frequently such overt attention to aligned text occurred. In the next section, we will present data on the total fixation duration and number of fixations in a quantitative analysis.

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Descriptive data: Baseline turns and PSLA n-grams

Overall, the three pairs produced a total of 8,759 words (*M*= 2,920, *SD*=586, per pair) for all six experimental chat conversations. We identified 82 instances of exact lexical overlap of 3-to-10 grams of two chat partners, where we could draw *AoI*s. Output of the eye-tracking software revealed that at least one eye fixation was recorded in 58 *PSLA*s (47x 3-

grams, 10x 4-grams and 1x 5-gram). For baseline data, we analyzed 135 turns of the six

participants that had received at least one eye fixation.

Table 3 summarizes the descriptive statistics on the gaze behavior (Total Fixation Duration / number of characters including spaces = TFD/char; Fixation Count / number of characters including spaces = FC/char) for our six participants on the baseline turns and the *PSLA* n-grams. Baseline data average the gaze behavior over one full chat session per participant. *PSLA* data summarize the gaze times and counts for the 58 *PSLA*s that had received gaze attention.

Please put Table 3 HERE

Comparisons reveal that for all participants *TFD/char* was longer on *PSLA*s than on baseline data even though differences are very small. The same holds for all participants but number 1 for *FC/char*. This time, differences are more pronounced, particularly for the US participants (4, 5, 6), but also for UK participant 3. Mean scores on both measures reflect this general impression, which is even more apparent when looking at the value calculated for average gaze behavior per word. Data further show large individual differences substantiated by high standard deviation values.

Comparing Baseline vs. Alignment data

Given the relatively small dataset, we looked at each individual *PSLA* and identified those that received higher (mean plus 1 SD) and substantially higher (mean plus 2 SD) gaze attention than the baseline data for that participant. As shown in

Table 4, out of 11 *PSLA*s we identified only two instances for participant 1 that had received higher ('the last part') and substantially higher ('nonanonymous and anonymous') values than the baseline. The latter *PSLA* only showed a substantially higher total fixation duration but not fixation count in comparison to the baseline.

Please put Table 4 HERE

By repeating this procedure for all six participants we found the list of *PSLA*s listed in Please put Table 5 HERE

and renamed them *Identified* Sources for Lexical Alignment. What is apparent in this list is the low frequency of some of the Identified Sources for Lexical Alignment (e.g., nonanonymous and anonymous) in contrast to others that reveal high frequent expressions (e.g., I am not). Furthermore, two 3-grams (oral cmc and ftf; written synchronous cmc – referring to oral computer-mediated communication and face-to-face and written synchronous computer-mediated communication, respectively) were identified twice for the same participants. As we have seen before, large individual differences exist. For example, we identified only one such expression for participant 5 but five instances for participant 6. Finally, it is worth noting that from the initial 82 *PSLA*s only 16, that is, 5.1% (or 27.6% of the 58 *PSLA* with gaze data) were identified as having received higher fixation duration and/or counts than baseline reading behavior would expect.

Please put Table 5 HERE

Quantitative Analysis

Using inferential statistics, we tried to further identify the value of our two predictor variables (*TFD/char* and *FC/char*) to identify sources of lexical alignment. The binomial response variable was alignment (yes=1/no=0) where overlapping N-grams (*PSLA*s) based on the chat transcripts were coded as 1. All baseline text was coded as zero. Because of the difference in hardware and software used by the UK and US groups, statistical analysis of the two groups' performance was kept separate.

A separate regression analysis was run on the combined baseline (*n*=135) and *PSLA* (*n*=58) observations for each group (UK and US) with *TFD/char* and *FC/char* as predictor variables and alignment as the (binominal) single criterion variable. For the UK group, neither variable returned a significant result. That is to say, neither variable discriminated very well between the *PSLA*s and baseline behavior. Likewise, *TFD/char* was non-significant for the US group. However, the *FC/char* measure was a significant predictor of *PSLA* for the US participants. We ran a second regression for the US group alone with *FC/char* as the sole predictor variable. As shown in

Table 6, results suggest that the standardized fixation count is a powerful predictor of alignment. For each unit increase in the index (*FC/char*), coding the respective target as "alignment" (rather than no alignment) was over 86 times more likely (Exp(B)=86.472).

Please put Table 6 HERE

Based on this procedure six cases of the 23 PSLA in the US data were identified as sources of lexical alignment. A concordance program was used (Cobb n.d.) to examine the actual text of these phrases. Table 7 shows that in four of the six targets, 'off list' words were present (i.e., words that were not K1, K2, or academic words, according to the corpus). These include words like 'asynchronous,' 'L2,' 'f2f,' and 'online.' In the remaining two instances, all words in the aligned text were K1 words (1,000 most common).

Please put Table 7 HERE

Discussion

This chapter is a theoretically and methodologically explorative study into using eye-gaze measurement as an indicator of lexical alignment during SCMC among peers in their second language. Our first research question asked to what extent L2 peers align at the lexical level when interacting via text-based SCMC during task-based interaction. Our second research question inquired whether eye-tracking technology can help us disentangle explicit, overt attention to an interlocutor's output from implicit processes of aligned production. Chat-logs of six task-based 20-minute chat interactions were compared for exact lexical

overlap of 3-to-10-grams. Out of the nearly 9,000 words, 82 instances of shared text were coined Possible Sources for Lexical Alignment (*PSLA*) and eye-tracking software was used to extract eye-gaze measurements (standardized Total Fixation Duration and Fixation Count) on those targets as they moved on the screen during the dynamic text chat interactions. Comparisons between gaze data on baseline and experimental data identified 16 instances of lexical overlapping n-grams as sources for lexical alignment (identified source for lexical alignment). This is 28% of those *PSLA*s that had received at least one eye fixation. A regression analysis on part of the data identified fixation count (*FC/char*) but not total fixation duration (*TFD/char*) as a strong predictor for *PSLA*s when compared to baseline data. Six out of 23 (i.e., 26%) *PSLA*s were identified due to higher fixation counts. Together with qualitative screenings of the data that showed clear examples of visual attention to aligned text, our data do give some support for lexical alignment based on overt attention to the partner's language. However, the majority of lexical overlap did not go hand in hand with increased overt visual attention or noticing (as operationalized by Godfroid et al. 2013).

Methodologically, this study shows that eye-gaze measurement can support attempts to tease apart which cases of potential alignment are linked to more overt attentional behavior. Even though we worked with a small data set, the results partially confirm earlier work by Smith and Renaud (2013) who suggest that fixation count (rather than total fixation duration) is a good indicator of what learners attend to during task-based SCMC interactions. For part of our data, the fact that *FC/char* was a predictor of alignment over baseline text suggests more overt attention to aligned text than baseline text, as measured by *FC/char*.

In the present study, there were many cases of potential alignment for which fixation count was under the required threshold. In these cases, there are two possible explanations. First, these could be simply coincidental occurrences that appear as overlap on the chat transcript. In this case our findings would suggest that earlier work in this field, which relied

on chatlog analyses (Collentine & Collentine, 2013; Michel, in press), might overestimate the actual alignment taking place.

A second option is that these cases indeed reflect alignment, but they are not going hand-in-hand with overt attention. This could be interpreted as an indication that the L2 alignment is more implicit in nature, which is consistent with the theory behind L1 alignment (Pickering & Garrod, 2004). Yet, as the current study did not measure awareness (e.g., by means of stimulated recall), we cannot draw any firm conclusions in this respect.

For our data, it might be that the increased salience of SCMC conversation frees attentional capacity as it decreases the need to rely on working memory. In this context, 'normal' as opposed to excessive gaze behavior could be enough to activate and appropriate the same lexical items. In our data, alignment may occur in L2 speakers because their processing limitations – in comparison to L1 speakers (Costa et al., 2008) – are mediated by the medium of SCMC.

Branigan et al. (2007) suggest that lexico-semantic alignment is thought to be more conscious than alignment at the morpho-syntactic level because of conversation strategies that help us to avoid nonunderstandings. Yet, most of our participants' alignment seems not to follow exceptional overt attention to their partner's output. In fact, at least one of our participants demonstrated a habit of only rarely reading what the partner wrote. Most of the reading focused on reviewing her own contributions in the chatlog and monitoring and editing her own messages before sending them, which is typical behavior during SCMC (O'Rourke, 2012; Örnberg Berglund, 2012, 2013). Another reason why our participants might not show much overt excessive attention to their partner's output could be the fact that they were conversing with a peer. Kim and McDonough (2008) found that target language partners tended to elicit more primed production in learners than peers. Other contextual factors (e.g., prompt frequency, McDonough & De Vleeschauwer, 2012) are likely to have

played a role too. Following Marsden et al. (2013), this study could imply that for alignment to become pedagogically useful, it might be important to explicitly teach language learners to benefit from the increased salience during SCMC and instruct them to review their partner's contributions as a source for their own messages. As a whole, our study is in line with earlier work in both pedagogic L2 priming and eye-tracking SCMC as we yielded some support for overt attention to aligned text – be it to a limited extent only.

Finally, a noteworthy methodological contribution of this paper is the use of n-gram analyses in alignment research. We have shown that limiting automatic search for overlapping text to multi-word units of at least 3 words allowed us to work with a meaningful set of target structures that was manageable in terms of the further manual coding of the eye-gaze data. We would encourage that future research follows this same approach.

Limitations and directions for future research

The most obvious limitation to this study was our modest sample size (*n*=6). Each location in this study had one eye tracker, which meant that participants' eye-gaze was tracked one dyad at a time. Practical constraints prohibited including more participants with the time available. Second, although we attempted to sculpt a series of highly relevant academic tasks for this study, in the final analysis, we are left with one task type, namely, a sort of information gap task. This may have affected the nature of learner eye-gaze captured. The dual site nature of the study creates another layer of complexity. First, two different types of hardware and software were used for data collection and analysis. This surely limits the ability to consider the data as a whole. Similarly, the time difference between the UK and the southwestern US may have reflected a difference in learner fatigue as data collection commenced in the late evening in the UK.

In our data collection and analysis, we employed 3-10 gram strings of lexical overlap as our basis for determining alignment. Future studies may wish to look at structural overlap. Though we did observe some syntactic alignment, this was not the focus of this paper. A careful analysis of syntactic alignment may reveal a different picture in terms of the nature of alignment during task-based SCMC.

Finally, the choice of using total fixation duration and fixation count is somewhat arbitrary. Nevertheless, we feel that these two measures are reasonable given the nature of the text (SCMC) being eye tracked. Future studies may wish to incorporate another layer of data elicitation such as stimulated recall.

Conclusion

Text-based SCMC interaction has been argued to enhance the visual salience of forms, which promotes noticing. This coupled with the persistence of the input and reduced conversational tempo in this modality combine to make input more salient to learners during text-based SCMC and, therefore, create conditions facilitative for language learning. Indeed, the visual and orthographic nature of SCMC input may lead to stronger long-term memory traces than acoustic, phonological forms, as found in speech. Viewed another way, salience in the SCMC environment may be the result of differences (an increase) in noticing opportunities.

Capitalizing on these affordances of text-based SCMC, the current study has employed eye tracking technology in an attempt to disentangle overt attention to (and noticing of) an interlocutor's output from implicit processes of aligned production. Though the current data set is too small to present any robust conclusions, the present study has made some theoretical and methodological contributions to the investigation of lexical alignment during text-based peer SCMC in an L2 and the use of eye-tracking methodology in a text chat

environment. First, it seems that only a small amount of lexically aligned text goes hand-in-hand with heightened overt visual attention, which suggests that alignment in an L2 – like in L1 – might be the result of unconscious implicit processes rather than strategic explicit behavior; second, our data indicate that it is fixation count (rather than fixation duration) that might reflect the increased salience of an interlocutor's input and therefore predict noticing during text-based SCMC; and third, combining corpus-based n-gram analyses of chat-logs and measurement of eye-gazes during SCMC has shown to be a fruitful methodology to investigate how the salience of the interlocutor's contribution might influence L2 use by a chat partner. Finally, it must be acknowledged that due to large individual differences in gaze behavior any generalizations are difficult to make based on the current findings.

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Appendices

Appendix A. Week 1: Getting to know your partner

Task 1

Try to collect the following information from your partner. In turn, you will be asked to chat a bit about yourself and your studies. You have 15 minutes to get to know your partner.

A. Name:　　B. Age:　　　　　　　C. Gender: male / female

D. Mother tongue / cultural background?   E. How long has your partner been in the

UK/US?

F. What is your partner studying?

G. Has your partner ever learned a language through CALL (computer assisted language

learning)?

H. Ask some more details about this experience, e.g., What did your partner like or dislike

about it?

I. Does your partner have experience with online teaching?

J. Ask some more details about this experience, e.g., What did your partner like or dislike

about it?

K. Anything else you want to know and ask…

Tables, Excerpts and Figures

Tables

Table 1. Participant characteristics

Participant / Country of residence	Age	Gender	L1	Years of studying English	Months in L2 country	Self-rating for writing (CEFR)	Proficiency out of 150 (%)[a]
1 / UK	23	female	Chinese	10	2	C1	142 (85)
2 / UK	35	female	Nepali	14	1	C1	128 (85)
3 / UK	22	female	Chinese	10	13	C1	141 (94)

4 / US	23	female	Taiwanese /Chinese	15	8	B2	137 (91)
5 / US	26	male	Arabic	12	3	B2	137 (91)
6 / US	29	male	Arabic	6	8	B2	128 (85)

[a] http://www.transparent.com/learn-english/proficiency-test.html

Table 2. Example chatlog of P5 and P2 interacting on the beginning of an abstract in the experimental session 1. Coding shows two *PSLA*s: The 4-gram 'what do you think', first mentioned by P5 in turn 10 and later repeated by P2 in turn 30. The 3-gram 'of the study' was used first by P2 and repeated by P5 in the contingent turn 12.

Turn	Time	Participant	Text
10	18:28	P5	*what do you think*
11	18:28	P2	i think we can start by mentioning the main objective *of the study*
12	18:28	P5	in the beginning *of the study* i think we may introduce what the study is all about
[…]			[…]
30	18:31	P2	*what do you think* about the background of the learners

Table 3. Descriptive Baseline and *PSLA*

Participant	Baseline, Mean (SD)			PSLA, Mean (SD)		
	N	TFD/char	FC/char	N	TFD/char	FC/char
1	15	.074 (.085)	.369 (.383)	11	.084 (.084)	.353 (.362)
2	42	.176 (.204)	.844 (.872)	12	.199 (.306)	.867 (1.108)
3	43	.114 (.152)	.565 (.638)	12	.151 (.134)	.746 (.516)
4	16	.036 (.449)	.163 (.127)	9	.147 (.313)	.700 (1.389)
5	11	.031 (.021)	.187 (.114)	2	.037 (.008)	.307 (.080)
6	8	.041 (.043)	.159 (.107)	12	.068 (.061)	.285 (.218)
Mean	22.5	.079 (.057)	.381 (.277)	9.7	.114 (.061)	.543 (.257)
Per word		.360	1.743		.523	2.483

Note. *PSLA* = Possible Source for Lexical Alignment; N= Number of observations; TFD/char = Total Fixation Duration / character; FC/char = Fixation Count /character; per word = hypothetical value calculated on the basis of average of 4.57 characters per word in *PSLA*

Table 4. Higher values than baseline plus 1 (bold) or 2 (bold italics) SD for participant 1

PSLA	# char	TFD	TFD/char	FC	FC/char
I think we should	17	.077	.005	1	.059
better than online	18	.083	.005	1	.056
not better than	15	2.149	.143	9	.600
you think about the	19	.460	.024	2	.105
i don't think we	16	1.493	.093	7	.438
I think we	10	.473	.047	2	.200
the last part	13	2.516	**.194**	10	**.769**
nonanonymous and anonymous	26	6.772	***.260***	25	**.962**
see you next week	17	.283	.017	1	.059
to find the group	17	.786	.046	3	.176
Im not sure	11	1.036	.094	5	.455

Note. *PSLA* = Possible Source for Lexical Alignment; # char= number of characters; TFD/char = Total Fixation Duration/character; FC/char = Fixation Count/character; **bold**= higher value than baseline plus 1 SD (TFD/char= .158; FC/char=.752); ***bold italics***= higher value than baseline plus 2 SD (TFD/char=.243; FC/char=1.135).

Table 5. Identified Source of Lexical Alignment (ISLA) based on baseline comparison for all participants

	ISLA	# char	TFD	TFD/char	FC	FC/char
P1	the last part	13	2.516	.194	10	.769
	nonanonymous and anonymous	26	6.772	*.260*	25	.962
P2	oral cmc and ftf	16	6.138	.384	26	1.625
	oral cmc and ftf	16	17.918	*1.120*	67	*4.188*
P3	written synchronous cmc	23	6.418	.279	24	1.043
	written synchronous cmc	23	10.751	*.467*	45	*1.957*
P4	the written synchronous	23	1.587	.069	9	.391
	L2 vocabulary learning	22	1.606	.073	10	*.478*
	as a measure	12	1.116	.093	6	*.500*
	I am not	8	7.824	*.978*	35	*4.375*
P5	But I think	11	.462	.042	4	.364
P6	nice to meet	12	1.608	*.134*	4	.333
	better than online	18	2.322	*.129*	12	.667
	It is asynchronous	18	3.798	*.211*	14	.777
	The rest of	11	.407	.037	3	.273
	it is OK	8	.720	.090	3	*.375*

Note. ISLA = Identified Source for Lexical Alignment; # char= number of characters; TFD/char = Total Fixation Duration/character; FC/char = Fixation Count/character; *italics*= higher value than individual baseline plus 2 SD for each participant.

Table 6 Relationship between Fixation Count and Alignment (US group only)

	B	S.E.	Wald	df	p	Exp(B)
FC/char	4.4598	2.0131	4.9079	1	.026	86.472
constant	-1.4179	.5138	7.6167	1	.005	.242

Table 7. Identified Source of Lexical Alignment (ISLA) based on statistical analysis (US group)

	ISLA	#char	TFD	TFD/char	FC	FC/char
P4	L2 vocabulary learning	22	1.1606	.073	10	.478
	as a measure*	12	1.116	.093	6	.500
	I am not*	8	7.824	.978	35	4.375
P6	better than online	18	2.322	.129	12	.667
	It is asynchronous	18	3.798	.211	14	.777
	It is OK	8	.720	.090	3	.375

Note. * = containing only K1 words; ISLA = Identified Source for Lexical Alignment; #

char= number of characters; TFD/char = Total Fixation Duration/character; FC/char =

Fixation Count/character

Excerpts

Excerpt 1. Use of 'vocab' by both participant 2 and 5

Turn	Time	Participant	Text
40	6:36:52	P5	maybe how do learners acquire **vocab**
41	6:37:19	P5	or what is the most effective way to teach **vocab** to learners of different levels
[…]			[…]
48	6:39:28	P5	but i think this study is not only concerned with how learners learn **vocab**
[…]			[…]
60	6:43:01	P2	i think multimedia and **vocab** learning

Figures

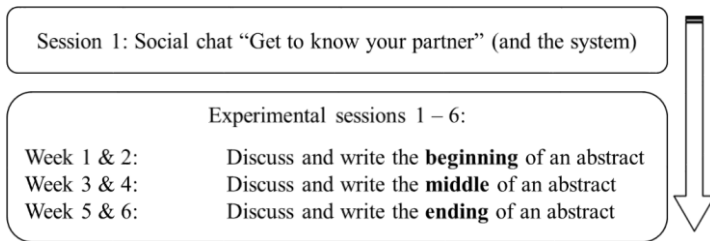|	Study Keywords	Research Questions	
Beginning	CALL, Anonymity Effect, Motivation, Vocabulary Learning, Asynchronous Discussions, Quality of L2 use	This study investigates L2 attainment in asynchronous online environments, specifically possible relationships among anonymity, L2 motivation, participation in discussions, quality of L2 production, and success in L2 vocabulary learning. It examines, in asynchronous discussions, (a) if participation and (b) motivation contribute to L2 vocabulary learning, (c) if motivation is related to level of participation in anonymous versus non-anonymous discussions, and (d) if a student's quality of L2 use varies in anonymous vs. non-anonymous discussions.	
Middle	**Basic design & Method** • All students engaged in asynchronous discussions • Independent Variables: anonymity, L2 motivation, participation in online discussions, quality of L2 production. • Dependent variable: L2 vocab learning.	**Participants** • N=87 • High school students • Spanish level 2 **Tasks** Asynchronous computer-mediated communication (ACMC), that is, discussion forums	**Analysis & Measures** • Pre-test cloze activity • Post-test cloze activity • Receptive vocabulary test • Transcripts of interaction • L2 motivation survey

	Results revealed that students who participated in the asynchronous discussions received significantly higher scores on the post-test than those who did not. In terms of level of participation, non-anonymous forums may have a comparative advantage over anonymous ones for learners with high levels of *introjected regulation*, whereas for learners with high levels of identified regulation, both forums are advantageous. *Introjected regulation* was the only significant predictor of success in learning L2 vocabulary. Finally, non-anonymous forums seem to generate higher quality L2 production than anonymous ones
Ending	

Figure 1. Example experimental task: reconstruct middle part of an abstract.

Figure 2. Design of the study

Figure 3. Experimental set-up showing the task (reconstruct the middle part of an abstract) on the left and chat window of the interaction between participant 3 and 4 on the right (including superimposed eye-gazes).
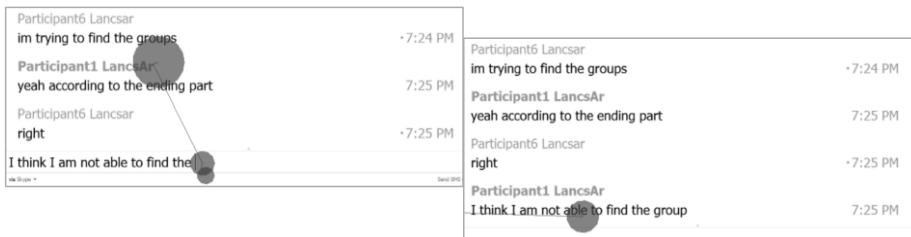
Figure 4. Screen shot of participant 1 paying attention to participant 6's earlier writing of 'to find the groups' while writing herself 'to find the group' (left) as demonstrated by the screenshot seconds later with the output of both partners (right). Note. Grey dots represent eye fixations (the larger the longer).
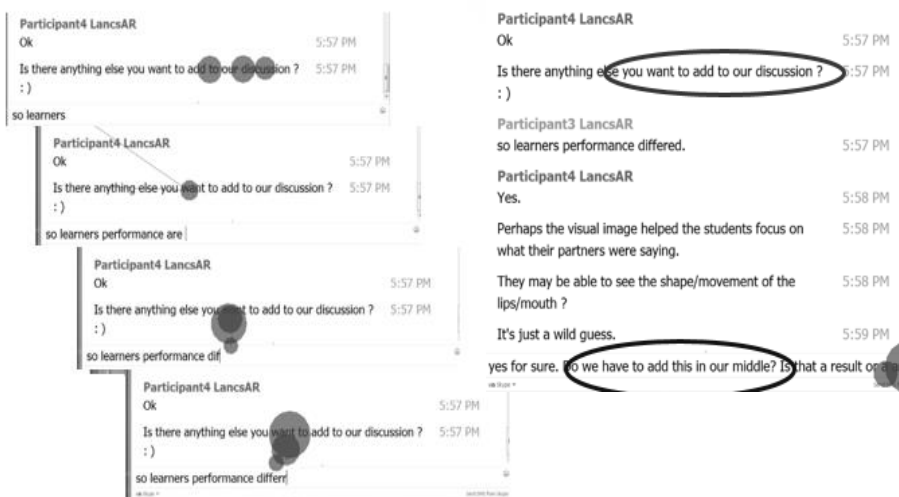

Figure 5. Example of multiple instances of overt attention to model structure (left) aligned to a few turns later (right).