DRAFT: Territorial Functioning in Collaborative Writing – Fragmented Exchanges and Common Outcomes

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Abstract

This paper examines territorial functioning in collaborative writing through a mixed methods study involving interviews and analysis of collaboratively authored documents. Our findings have implications for the way we think about collaborative writing as a design problem, in that current conceptualizations of collaborative writing emphasize the work context rather than the work itself, at the cost of understanding interpersonal dynamics that are central to the common process. The findings come from 23 interviews with 32 university researchers and students regarding their experiences with collaborative writing of academic texts. The analysis of these interviews is supplemented with visualizations of the revision histories of documents written by a subset of the study participants. We discuss our findings in terms of fragmented exchanges in common information spaces and consider the shared document as a mediator for the simultaneous accomplishment and negotiation of work.

1 Introduction

Collaborative writing is a broad topic, covering multiple modes of working; from synchronous, co-located writing [19] to asynchronous, distributed writing among

strangers [57]. Addressed early on in CSCW, focus was on the technical feasibility of project management [14], synchronous editing [17], change awareness [43], and a decade later workspace awareness [23]. With the improvement of tool support collaborative writing has become common in several areas, including education [63, 30], industry [55], and research [6], and more effort has been devoted to practices for collaborative writing [45, 62].

This paper presents findings from an interview study on collaborative writing, primarily (but not exclusively) focusing on synchronous collaborative editors, supplemented with analyses of editing patterns in collaborative documents authored using these editors. Participants were university students and researchers and the documents analyzed comprise student projects, master's theses and scientific papers. The research is part of a larger effort towards understanding how collaboration and sharing is mediated by technology, as well as a push for re-thinking this technological support.

In the meeting of multiple people who contribute to the production of content it is not unlikely for some of these people to develop an attachment to what they have produced, as has been shown with respect to Wikipedia [57, 24]. This attachment has in some of these cases resulted in territorial protection and curation of content, thus influencing and sometimes even hindering further production and development. So far, this sort of territoriality has only been examined in the context of Wikipedia, meaning that the content over which territoriality is exhibited is produced over long-term periods of multiple years with infrequent major edits as the content matures. Other work in CSCW has addressed very short-term (almost micro-term) territoriality in the context of tabletop interaction [51]. In this context, research has addressed people's maintenance of and respect for personal territories in the immediate interpersonal interaction around regular and interactive tabletops.

In between these two scales of territoriality we have identified a gap in current research. In our studies of collaborative academic writing we have taken note of a territorial behaviour that has not previously been addressed in CSCW. Segmentation of text in collaborative writing has previously been addressed as a general strategy applied by writers [62]. This and other studies have examined editing patterns in collaborative documents, typically of collaborations lasting between a one hour and a few days [63, 45]. Our findings extend these by looking at collaborations spanning weeks and months. It is in these collaborations that we have identified a territoriality in connection with segmentation of the text being worked on.

Our motivation for this research is to understand 1) how the work of multiple

writers becomes aligned in the production of text as common material and product, and 2) how these processes are influenced by current technological support. This leads us to the following research questions:

- What are writers' motivations for territorial behavior?
- What means and strategies do writers apply to support territorial functioning?
- How are territorial practices negotiated during the writing?
- What challenges can we identify regarding the mediation of territorial functioning?

Our main contribution is empirical and theoretical: We present empirical findings from interviews and document revision logs that demonstrate territorial behavior in writing, and we discuss the implications of these findings on how we conceptualize this territoriality. Additionally we suggest implications of territorial writing behavior for CSCW research and design.

2 Theoretical Background

In this section we first introduce territoriality as a theoretical concept, before we discuss theoretical notions from CSCW that are central to our discussion of territoriality in collaborative academic writing: We begin by outlying Schmidt and Bannon's notion of *common information spaces* as well as Boujut and Blanco's [8] analytical concept of *intermediate objects*. Then we describe the role of *double-level languages*, developed by Robinson [48], with respect to articulation work. This is extended to include a perspective on disarticulation, discussed in terms of Clement and Wagner's [12] notion of *fragmented exchanges*.

2.1 Territoriality and Territorial Functioning

Definitions of territoriality differ. Understandings of what counts as a territory vary, as do characterizations of territorial behavior. Taylor [56] outlines a number of understandings, including that of an active defense, a defense achieved without aggression, laying claim, creating and maintaining boundaries, or the signalling of claims through markers and warnings.

Taylor [56] describes *territorial functioning* as place-specific and shaped by shared subjective definitions or perceptions of the given locale. His precise definition reads:

> 'Territorial functioning refers to an interlocked system of sentiments, cognitions, and behaviors that are highly place specific, socially and culturally determined and maintaining, and that represent a class of person-place transactions concerned with issues of setting management, maintenance, legibility, and expressiveness.' [56, p. 6]

Taylor describes territorial functioning as a group-based process that is, among other things, relevant to solidarity. We interpret his use of the word *process* to mean that territorial functioning is territorial experiencing and acting while territoriality is the inclination for territorial functioning.

The purpose of territorial functioning is not simply to keep others out. The signalling of claims also serves to communicate expectations as to who is allowed in and how those entering the territory should behave [56]. Territorial functioning is thus about expectation setting and fulfillment regarding behavior within a given location. By extension it also relates to control over activities in specific sites.

Taylor [56] further describes territorial functioning as comprising *sentiments, cognitions, and behaviors*. Territorial functioning thus extends beyond behavior; it involves people's sentiments and perceptions of situations as well. It spans both purposive behaviors, such as explicit management of territories and the use of signs for this, and non-purposive behaviors such as responses of annoyance toward people who impose on the territory with their presence. Territorial behavior is as such not necessarily contemplated or intentional; nor are territories always permanent.

In contrast to Taylor, Bakker and Bakker-Rabdau state that people's 'sense of territory is not limited to physical space alone' [4, p. 11] and include in their examples of territoriality personal thoughts and attachment to tasks or roles. They define an individual's territory to be 'those areas in which he has special expertise, shows initiative, and takes responsibility — in other words, where he has control' [4, p. 11]. We would add to this the areas that people develop an attachment to, in line with Taylor's [56] idea of attachment through familiarity.

In their descriptions of territorial behavior, Bakker and Bakker-Rabdau focus on conflicts over territories, such as when a person's position in a job is threatened by someone else performing that job, and various emotional and behavioral responses to such conflicts [4]. This conflict-centric understanding is not appropriate for characterizing the practices described by our participants, as they for the most part consist of non-conflictual management of the collaborative work and social situation (we discuss this near absence of conflict in Section 7). However, Bakker and Bakker-Rabdau's more general conception

of what constitutes a territory includes relevant perspectives that go beyond Taylor's spatial understanding. While their classification of territorial behavior may not be applicable, their descriptions of emotional responses are useful for discussing some of the sentiments expressed by our participants.

Taylor [56] classifies definitions of territoriality along four organizing dimensions (see Figure 1). The *makeup* dimension addresses whether territorial functioning is primarily determined by behavioral or non-behavioral components. A behavioral understanding means that territoriality stems from behaviors associated with the specific physical, social, and cultural characteristics of a situation; while a non-behavioral understanding means that territorial functioning is rooted in perceptions and feelings about particular locations. The *interpersonal function* dimension has to do with whether the primary function of territorial behavior is perceived to be the establishment of dominance, or whether territorial behavior is perceived as facilitating social organization and social life. The *linkage with place* dimension regards the extent to which territorial functioning is understood as being influenced by physical features of the space and/or by social and cultural dynamics (akin to Hall's [25] concept of proxemics). The endpoints of this dimension are not mutually exclusive. The final dimension, *spatial extensiveness*, describes whether territories are understood as limited (and small) in spatial scope or as widely varying in size.

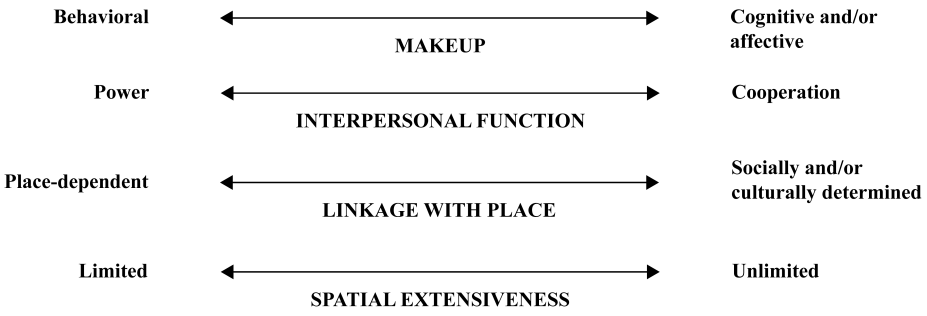

Figure 1: Our graphical depiction of Taylor's four organizing dimensions for definitions of territoriality.

Although Taylor's definition regards territorial functioning as relating to space, we find that this does not need to exclude virtual space (see also Dourish and Harrison [26] on the relationship between place, space and media space). In the case of collaborative writing the 'place' is in some sense a metaphorical or abstract one; the text and the document(s) containing it are perceived as locations. This is evident from some of the language used with respect to it

[32]: '*in* the document', 'what page *are you on*?'.

In the following analysis of collaborative writing, we use the word *territory* to mean an amount of text with which a particular person is the main affiliate and over which that person perceives and/or is perceived to have a right to control. In the end of Section 5 we present our conceptualization of territoriality in collaborative academic writing using Taylor's classification. Below, we describe concepts from CSCW that will support us in applying the psychological perspectives on territoriality presented above to our findings.

2.2 Collaborative Work

Collaborative work presents a particular challenge compared to individual work due to the added effort of placing material in common in a way that it is understandable and useful to multiple actors [5]. Continuous communication, negotiation, and time-keeping play a crucial part in collaborative writing. According to Bannon and Bødker [5], such articulation work [50], requires the construction and maintenance of a *common information space*; a term that Schmidt and Bannon [49] use to refer to a collection of information with differing origins and context, which holds a shared meaning to a group of collaborating actors and which is maintained by them employing 'different conceptualizations and multiple decision making strategies, supported by technology' [49, p. 22]. This definition is very suitable for the instances of collaborative writing that we have studied. Writers bring different skills and thus goals and perspectives to the table and participants in our study have described intricate variations in the strategies employed, depending on the type of decision to be made, on who is involved in it, as well as on the timing of it. The technological mediation of this is central since the collaboration, as it looks today, could not take place without it — factoring out cloud storage, version control, e-mail, instant messaging, and so on would remove most of the current collaboration, even for co-located groups.

Schmidt and Bannon emphasize that cooperative work is not facilitated by technology simply allowing the sharing of information — rather it requires actors to actively construct an information space in which the meanings of shared objects are negotiated [49]. Communication and information sharing is required in order for actors to distinguish what is central to the joint work in a particular situation [5]. These negotiations and communication can be understood as what Lee [33] calls *boundary negotiating*. As a model that aims to widen the perspective on coordination provided by boundary objects [54] it does not

presuppose high levels of coordination or standardization, and it embraces both coordinative and disruptive aspects of collaboration. As such it aims to help describe collaborative work characterized by partial alignment and incomplete shared understanding.

Lee emphasizes the coordinative role of artifacts, one example being *intermediary objects* [8]. Intermediary objects are shared representations that foster cooperation by mediating understanding and are 'oriented towards interaction and knowledge dynamics' [8, p. 212]. Intermediary objects are both the traces and the output of the creation process and as such represent either the product or the process. They thereby crystallize conventions and rules, providing collaborators with a 'shared frame for co-operating' [8, p. 216] and supporting the creation of local conventions. We have picked up the notion of intermediary objects as an analytical perspective for this work because of the character of collaborative writing as a process of creation of a text/document that is simultaneously the object of work and a mediator for the process. The document/text in its intermediate states serves as an intermediary object mediating the collaboration, feeding into its own further development.

Along with coordinative artifacts the technology in use also acts as a mediator for articulation work. Robinson's [48] notion of *double-level language* emphasizes the difference between two levels of communication: The *formal* level of communication is rule-governed and predictable and provides a common external point of reference for actors. In the *cultural* level, which is steered by norms and subjective interpretations, a co-constructive process takes place through interaction. According to Robinson, CSCW applications need to support both the formal and the cultural as interacting levels of communication. In this way, both the factual and the social context are mediated, allowing people to discover each other's subjective viewpoints through conversation in both formal and informal encounters. Supporting only a formal level of communication removes meaning from interactions taking place through the system, disabling mutual influence and adaptation among actors [48]. The notion of double-level language provides a perspective on CSCW applications, such as those for collaborative writing, in which the capabilities for articulation work can be scrutinized.

Just as central as articulation work is the enactment of informational regionalization, in what Clement and Wagner [12] refer to as *fragmented exchange*. Clement and Wagner discuss articulation work and the counterpositional need for *disarticulation* in collective communication spaces. Based on the argument that communications in the physical world have a regionalized character that

captures and supports operationalization of competences and roles, they argue that technologically mediated shared contexts require consideration of 'the politics of sharing and withholding' [12, p. 33]. Disarticulation can, for example, be motivated by the desire to protect a practice or for control over blame and credit, as well as by information overload or protection of personal boundaries. Heath et al. [27] provide a similar argument, describing collaborative work as an 'ongoing and seamless transition between individual and collaborative tasks' [27, p. 89] which relies on the continuous adjustment of people's access to each other's activities.

3 Related Work

3.1 Territoriality in CSCW

Work on interactive tabletops and shared displays has shown that users perceive and act according to a territorial division of the workspace [51, 42, 46, 58, 10, 36, 59, 35]. Multiple studies in this area have also made distinctions between personal and public artifacts [21, 52, 53, 41, 40, 2, 36, 18]. The word *territory* is typically used simply to refer to an area of the table or display that is associated with specific people (potentially the entire group). A spatial reasoning is often applied as part of the explanation for territorial behavior, such as personal territories enabling users to perform actions without ergonomic strain [51].

Thom-Santelli et al. [57] conducted interviews with Wikipedia users who maintain articles. They examine notions related to territoriality such as ownership, boundaries, and control, and they describe users' feelings of attachment to their articles as well as opinions regarding their own and others' way of editing, such as discontent with new editors making substantive changes to maintained articles. Thom-Santelli et al. argue that territoriality can be both beneficial and negative to the collaborative process and product.

Similar to the territorial attachment of Wikipedia article maintainers, Mockus et al. [39] have observed that software developers working on the Apache server obtain a form of ownership over code that they have created or are maintaining. This manifests in other developers showing greater respect for their opinions on changes.

3.2 Private and Social Writing

The idea of enabling a distinction between personal and shared during collaborative writing has been explored by several authors. When describing (and

critiquing) their NEPTUNE system, Delisle and Schwartz [14] argue that users should have the option of trying things out in private before showing their work. Dourish and Bellotti [16] present the collaborative text editor ShrEdit which has capabilities for private windows. Newirth et al. encourage similar capabilities on the grounds that writers 'may not wish to make their developing drafts public' [44, p. 145]. Posner and Baecker [47] describe the separation of individual writing using a different perspective, with an emphasis on division of work.

Wang et al. [62] discuss writers' reluctance toward 'writing together', including the observation that writers often write in a separate document and copy-and-paste their work into the shared document. They also suggest that collaborative systems should provide writers with a 'private writing place'.

Ignat et al. [29] outline the implications of technologically facilitating different levels of seclusion for users during collaborative work, in particular the issue of maintaining privacy while also avoiding concurrent modifications.

Birnholtz and Ibara [6] find that writers attribute social significance to edits and comments during collaborative writing, which can affect relationships between co-writers. This social aspect of collaborative writing is also emphasized by Lowry et al. [37] who characterize collaborative writing as a group act that requires activities extraneous to single-author writing, such as consensus building.

Cerratto-Pargman [11] likewise highlights the social aspects of collaborative writing. According to her, collaborative writing is 'mediated twice', through both technology and the experience of interacting with others. Cerratto-Pargman argues for shifting focus from task support for individuals or groups to support for relationships between individuals. This involves recognizing the tension between shared and personal space, and enabling seamless transitions between individual work and collective efforts [11].

4 Study and Methodology

To study collaborative writing in modern tools that facilitate collaboration, we recruited groups of students, predominantly working on their master's thesis, and researchers writing conference papers and/or book publications. We selected both students and researchers to include groups of equal peers (students) and groups in which authority and role might differ between authors (researchers). *Note that master's theses in Danish universities are frequently carried out as group work by two or three students who submit a thesis authored together.* The students either jointly carry the full responsibility for all content

or may be required to specify which parts of the work and report each student has been responsible for. All of the student groups interviewed for this study worked by the model of joint full responsibility, according to their official statements to the universities with which they were affiliated.

The collaboration history within the groups ranged from working together for the first time up to three decades of collaboration. However, in all groups there were at least two members who had four months experience or more working with each other.

The study evolved from the initial interviews in March 2018 over a second round of interviews with an additional set of participants in July and early August 2018. During that time we started exploring ways of examining the insights from the interview study through various document data made available through the platform used for writing by participants. Following a small survey of techniques for analyzing document revisions, primarily in Google Docs (e.g. Sun et al. [55] and Wang et al. [61]), we decided to explore the emerging themes (see section 5) by examining revision data from some of the documents produced by the participants. Later in August 2018 we conducted a series of follow-up interviews with the groups whose document revisions had been examined.

4.1 Qualitative study

During the first two rounds of interviews we conducted 23 semi-structured interviews with 13 students and 19 researchers spanning 18 collaborative writing projects (see Table 1). The student groups were interviewed in groups and, because of the expected differences in authority and role, researchers were interviewed individually. Each interview lasted between 50 and 86 minutes, on average 64 minutes. The follow-up interviews, described in further detail below, lasted between 39 and 75 minutes, on average 58 minutes.

The interviews focused on both practical and social aspects of the collaborations: Writing strategies; division of labor and document sections among writers; ways of editing text written by others and ways of coping with others editing one's own text; personal strategies for draft writing; approaches to decision-making during the writing process; and the on-going negotiation of tasks and approaches. Particularly the latter two types of questions were aimed at eliciting insights about articulation work and the role of intermediary objects. The interview questions were divided into four topics, each covering a number of questions:

1. *Project*, focusing on details about the project and the group of collabora-

Table 1: Study overview: Group ID, group size and interviews, outcome type, project duration, and primary writing tool. The group ID is used as reference in quotes. Dash (-) letter indicate Student/Research group.

Group ID	Size (# interviewed)	Type	Duration	Primary writing tool
G-S01 ∗	4 (3)	Student project	34 weeks	Google Docs
G-S02 ∗	2 (2)	Master's thesis	17 weeks	Google Docs
G-S03 ∗	3 (3)	Master's thesis	19 weeks	Google Docs
G-S04 ∗	3 (3)	Master's thesis	19 weeks	Google Docs
G-S05 ∗	2 (2)	Master's thesis	24 weeks	Google Docs
G-R06	4 (2)	Paper	5 weeks	MS Word (Dropbox)
G-R07 ∗	4 (2)	Paper	5 weeks	Google Docs
G-R08	6 (2)	Paper	13 weeks	Google Docs
G-R09	5 (2)	Paper	4 weeks	ShareLaTeX
G-R10	2 (2)	Paper	18 weeks	ShareLaTeX
G-R11	3 (2)	Paper	19 weeks	ShareLaTeX
G-R12	2 (2)	Paper	2 weeks	Overleaf (Git)
G-R13	4 (2)	Paper	3 weeks	Overleaf
G-R14	3 (1)	Paper	1 week	LaTeX (Git)
G-R15	3 (1)	Paper	56 weeks	LaTeX (Git)
G-R16 ∗	5 (3)	Paper	28 weeks	Google Docs
G-R17	40 (1)	Book	32 weeks	LaTeX (Git)
G-R18	2 (2)	Book	3.5 years	MS Word (email)

tors involved.

2. *Tools and writing process*, focusing on tools and features used as well as process-related aspects such as coordination and timing.

3. *Drafts*, focusing on whether, how, and when the participants use drafts when writing collaboratively as well as when writing alone.

4. *Presence in the document*, focusing on the experience of working in a shared document where people's activities may be traced.

The questions remained the same throughout two rounds of initial interviews. The participants were not made aware of the four topics and the division into topics was not followed rigidly.

When we originally set out to do this interview study, the plan did not include a focus on territoriality in particular. We had a general interest in writers' perception of and behavior relating to segmentation of the work, but the topic of territoriality arose during the interviews and ensuing analyses, as a salient underlying theme deserving of a full analysis. This work should thus be seen as part of a greater research agenda on collaborative writing which acknowledges that there are many other themes to be covered, even though the scrutiny of these have been reserved for later writings.

The interviews were transcribed and analyzed through thematic analysis and meaning condensation [31]. The thematic coding took place as bottom-up identification of codes that were manually clustered into themes following the coding of all transcripts. We coded for both semantic themes, such as the means of communication mentioned by participants, and latent themes such as ownership [9]. The clustered themes are topics that were prevalent across interviews. As multiple codes contribute to a theme, some interviews mostly contributed to one subset of codes while others mainly contributed to a different subset of codes. For example, in the theme *ownership* some participants often spoke explicitly about ownership while other participants used other terms and/or hardly mentioned it, but on the other hand focused on accountability for produced content or achieving a feeling of shared ownership. We include salient and representative excepts from the interviews in the presentation of our findings and analysis.

These analyses were supplemented with data from seven follow-up group interviews (marked with $*$ in Table 1) in which we asked detailed and clarifying questions regarding discussions from the initial interviews. The follow-up interviews were structured and grouped into four topics: Content production and

Table 2: Analyzed documents: Group ID, number of documents analyzed, number of authors, total page count and total revisions count.

Group ID	Number of documents	Number of authors	Pages	Revision count
G-S01	1	4	29	12772
G-S02	1	2	68	119326
G-S03	8	3	96	364638
G-S04	1	4	81	170440
G-S05	1	2	68	68871
G-R07	1	4	14	19819
G-R16	1	4	43	34685

coordination; division and territories; collaboration, co-location, and timing; and coherence and ownership. The questions on content production and coordination were based on Posner and Baecker's [47] taxonomy and the strategies for text production identified by Wang et al. [61], and focused on the strategies that the participants had applied in documents on Google Drive which the groups had granted us access to (see Table 2 and below). The follow-up interviews served to corroborate or correct our conceptions of their writing processes.

4.2 Analyzing Document Revisions

To aid our analysis of how territorial functioning and other aspects of group collaboration manifest in the writing, we have developed a visual analytics tool that allows visual exploration of the edit history of a Google document. A few tools and plug-ins for visualizing Google document revisions already exist (e.g. Sun et al. [55] and Wang et al. [60]), but these tools enforce a different focus than what we find to be required for a fine-grained analysis of territorial behaviors. These other tools highlight e.g. relative individual contributions or the chronology of revisions. Furthermore, they separate the visualizations from the text in the document, making it difficult to explore the connection between revision data and document content or information obtained from the interviews. A secondary concern is the methodological implications in appropriating an analysis tool designed for a different purpose without knowing its inner workings.

The visualization tool developed to aid our analysis provides spatially structured visualizations that are coupled with the original text. The tool *a)* extracts the revisions using a technique similar to [60, 55], *b)* identifies spatial groupings of revisions, i.e. which paragraphs the revisions belong to based on their positions in the document (as opposed to chronology), and *c)* generates vari-

ous visualizations alongside a reconstruction of the document in a side-by-side view. The visualizations show which authors have made revisions where and when; and the side-by-side view allows identification of which revisions belong to which paragraphs. The corpus of data is revisions extracted from the documents shared with us by participants (see 2).

Our focus when studying the visualizations has been to identify patterns in the revisions relating to which authors have written what, where, and when. The visualizations have served to provide clarity for us in the writing of this paper, by letting us study indirect examples of the behaviors described by participants and include them here for illustrative purposes. Future work will involve presenting interviewees with visualizations of their own writing process to facilitate an in-depth discussion about the connection between practices and the patterns that manifest in the revision log. Such a study would require more space to discuss the concrete writing patterns and potentially make some more nuanced distinctions between the different group writing practices represented.

4.2.1 Reading the visualizations

We include examples of the visualizations in our analysis. Therefore, it is necessary to briefly introduce the three visualization levels. We visualize and distinguish between the ordering of the revisions in two ways. The chronology of the document refers to the history of the revisions. When extracted from Google documents, the revision data is organized chronologically, so that the first revision is the first activity in the document and the last revision is the last activity. It is important to note that there is no correlation between the chronology of revisions and their spatial position in the document. The latter, the spatial position in the document, we refer to as the spatial revision index. This is useful when trying to understand and explore where in the document specific revisions 'belong' in relation to other revisions.

The first level (Figure 2, right) visualizes the revisions of the entire document as blocks, segmented by paragraph so that each line of blocks represents one paragraph (defined as one or more lines between two line breaks). The blocks are color-coded, each color representing an author. The number of blocks in a line corresponds to the number of revisions in the paragraph; the variation in block size is thus due to all lines in the visualization having the same length despite the paragraphs having a different number of revisions, and the block size thus does not reflect any characteristics of the individual revisions.

This level of visualization emphasizes the spatial index of the revisions. This stacked view of the revisions allows exploration of larger patterns of territori-

ality in the document by illustrating author contribution and territories across multiple paragraphs and larger sections of the document. Figure 2 shows the document next to the stacked revision, with arrows added to indicate which line in the visualization corresponds to which paragraph

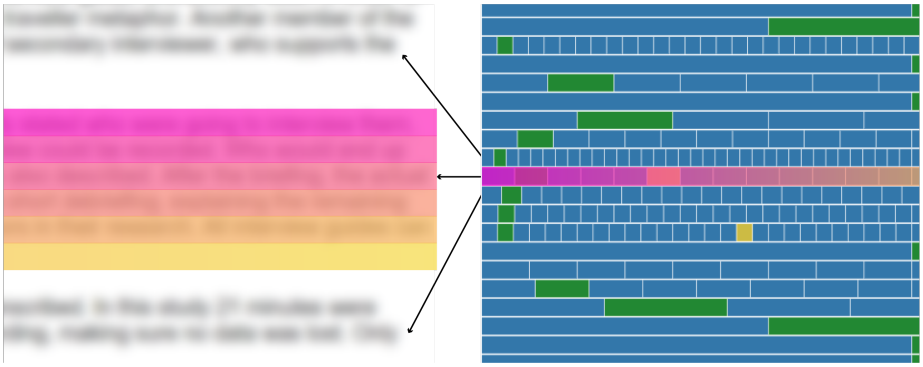

Figure 2: **Left:** Paragraphs in the document that is visualized on the right. The superimposed heat map indicates how the revisions highlighted in the visualization correspond to the spatial structure of the paragraph. **Right:** Stacked view with each line representing a paragraph in the document on the left.

The second level (Figure 2, right, highlighted) of the visualizations shows the revisions in a single paragraph. This is what each line in the stacked view shows, but we describe it in more detail here. The visualization shows revisions structured by their spatial index in the paragraph, so that revisions adding/deleting characters in the beginning of the paragraph are visualized in the left end of the line representing the paragraph, with spatially subsequent visualizations added further right in the visualization. Note that this order does not indicate the chronology of the revisions. This level of visualization allows exploration of which users have contributed to specific paragraphs and when.

The third level (Figure 3) shows the revision chronology in connection with the spatial index visualization on a paragraph level. The visualization retains the spatial index on the x-axis and visualizes the chronology downwards on the y-axis in sessions, i.e. revisions that have been added sequentially with breaks of less than 15 minutes (using the same temporal collaboration metric as [55]). The sessions are separated by a horizontal line detailing the time span between the sessions (days, hours and minutes). This visualization allows exploration of the temporal aspect of a single paragraph in relation to the spatial index of its revisions, thus supporting identification of collaboration patters.

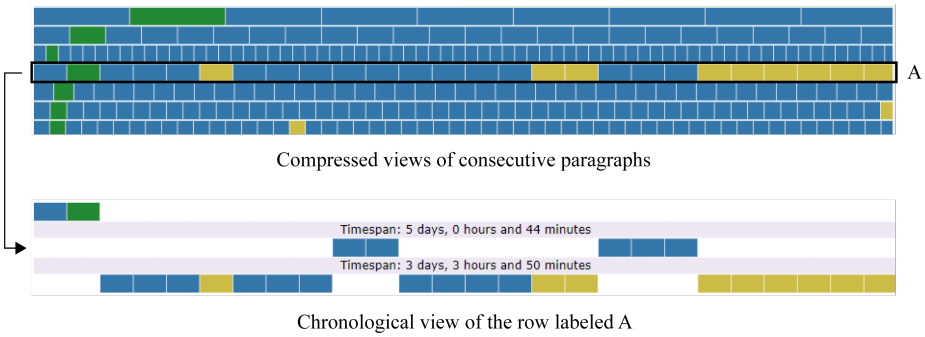

Figure 3: Combining the spatial revision index with the revision chronology. The x-axis is the spatial index and along the y-axis groupings of sessions separated by light grey bars with information about the time span are shown.

Figure 3 shows the combined spatial/temporal view along with an excerpt of the stacked view. An indication of which paragraph is being visualized has been added for clarity. In this example, the additional temporal dimension reveals that the green and the blue author have first contributed synchronously to what is now the beginning of the paragraph. After an inactive time span of five days, the blue writer has made revisions near the middle of the paragraph (at the time of the revisions: the end of the paragraph). Finally, after another inactive time span of 3 days, the yellow and the blue writer have worked synchronously on the paragraph.

5 Findings

5.1 Territories in Writing

It is clear from participants' way of describing their experiences of writing with others that they are attentive to territorial affiliation:

> '[. . .] as a student you write something and then, I mean, it's your thing. I mean, sometimes it's group work, but you respect each others sections so you don't go and edit them.' *(G-R15)*

In the visualizations we observe territories spanning several pages as well as clear shifts. Figure 4 shows the cleanest example from the data set. The first four paragraphs were left almost entirely to the writer represented by blue while the bottom three were left mostly to the writer represented by yellow (the large blue line was caused by a line break created by the blue writer). The second

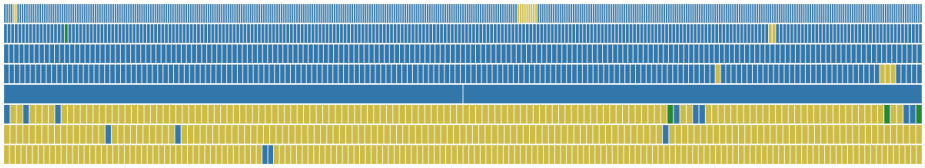

Figure 4: Two adjacent territories with a clean boundary *[G-S04]*.

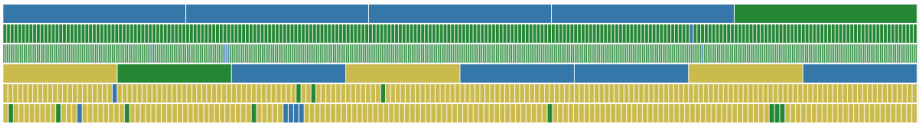

Figure 5: Another example of adjacent territories, with a bit more overlap around the boundaries *[G-S01]*.

example, in figure 5 shows a more common example, with a few overlaps around the border. A way of recognizing these shifts is to compare with cases where clear demarcation and territories are absent: In figure 6 we can observe a case where four authors are all involved in editing.

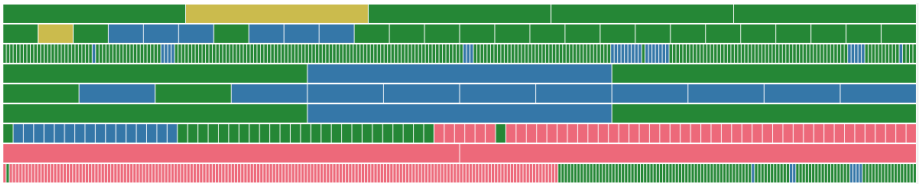

Figure 6: An example of a set of paragraphs with no clear territories *[G-R16]*.

A territory is not necessarily a connected or consecutive block of text. One participant described what he called 'logical blocks':

> 'We had these logical blocks and then you wouldn't touch the logical block [...] So you might be working in a logical block and that has a reference, there's some dependency in another block [...] It's about, there's something here that belongs as one argument.' *(G-R12)*

As the following participant states there is often an awareness of who different sections of the text 'belong' to, and so where and when writers edit when writing with others is not a trivial decision:

> '[...] for me to then go in and change his words feels like a violation in a way, right, I don't have the right to do that.' *(G-R10)*

> 'I have sometimes experienced with others, who have a really really hard time letting go of their text, right? That others make edits in it.' *(G-R18)*

Territories lie on a spectrum of permanence: There are regions of text that continue to be associated with one particular writer throughout the process, even after other people have been allowed to edit. They are thus controlled permanently by specific individuals. Figure 7 shows the visualization of a paragraph in which one writer (blue) has done a large majority of the editing, with a co-writer doing sparse editing throughout but never taking charge of the paragraph. There are also regions of text which are not associated with particular individuals or which may have a primary person in charge but are still freely editable. They may not be freely editable at any time, however: Participants frequently described a temporally local form of territoriality in which a writer's presence in a region means that other writers steer clear of it, in effect a kind of personal space. There is thus a temporal aspect to territories.

> 'You don't enter a section that's being written by someone else and start editing anything significant. Neither do you just sit and wait for something to be written, looking at it. Then you move on to see if there's something else you can work on. There are some sort of unwritten rules.' *(G-S04)*

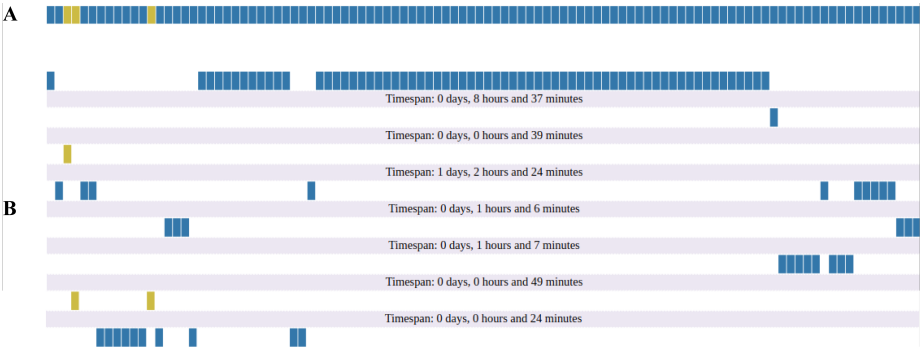

Figure 7: Permanent territory with co-writer performing only small edits. A) The spatial index visualization, B) The revision chronology. *[G-R07]*

Some of the participants also described a form of turn-taking in which a piece of text is 'handed over' from one writer to another. In these cases, there is always someone in charge of the text but who this is changes over time. We show an example of this in Figure 8, in which we see the control being transferred between three writers.

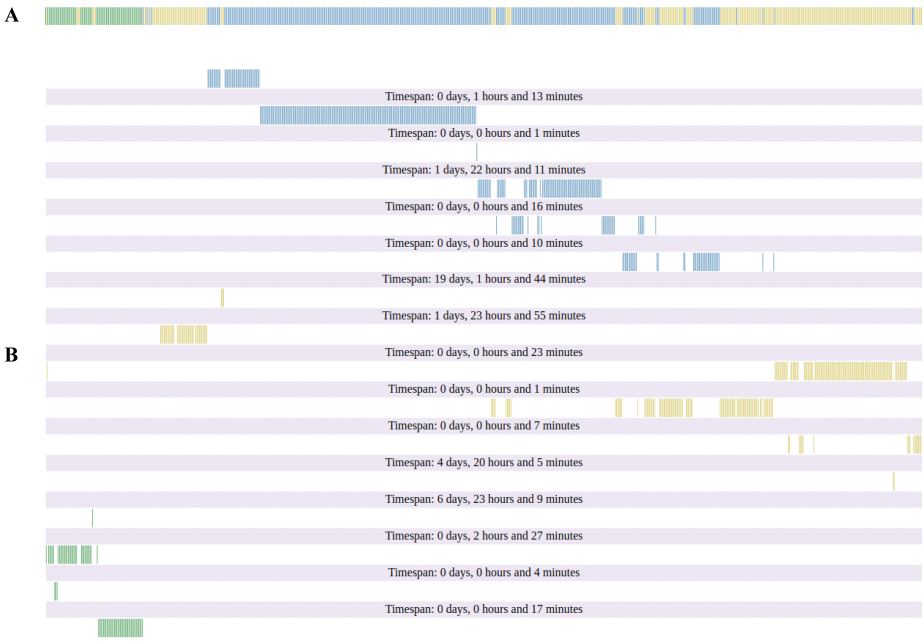

Figure 8: Turn-taking, with writers handing over control of a paragraph. A) The spatial index visualization, B) The revision chronology. *[G-S03]*

Because the non-permanent territories vary in their degree of ephemerality we feel that it is more useful to view all territories as being on a spectrum, rather than discussing totally permanent territories and other kinds as two separate types of territories.

5.1.1 Control

When we asked participants how text comes to be associated with certain writers, their responses typically had to do with an explicit division of work (by assignment of writers to different sections) or with who originally authored a given section. As assignment of a section leads to authorship of that section, control of sections thus comes down to authorship.

One reason for this is that the original writer acquires a form of local expertise. The difference between being the primary author of a region of text and being a visitor is comparable to borrowing someone else's messy desk; for the visitor the act of moving a piece of paper with scribbles on it may seem insignificant, but to the usual occupant this could be immensely disruptive to their work flow. In the same way the original author has a certain expertise in

navigating the particular region of text:

> 'I really mean the words that I'm using and why I'm using those words. So sometimes she changed that and I was like: Nope, that just doesn't work. Like, that breaks all kinds of other stuff because it is this symphony, right, all of these things somehow hang together.' *(G-R10)*

> 'But what if you change it and you remove the thing that made my brain click [...] Then I'm just reading an empty paragraph.' *(G-S05)*

Our notion of local expertise can be related to Bakker and Bakker-Rabdau's definition of a territory as an area in which the individual has special expertise (see Section 2). According to Bakker and Bakker-Rabdau, criticizing someone can be construed as enroaching on their territory. This view can explain why the indirect criticism contained in a modification of someone's writing without an invitation may be perceived as an intrusion. Bakker and Bakker-Rabdau [4] also note how delegation of responsibilities, and hence of competence, can result in a loss of territory; conversely, in maintaining the role as the local expert, a writer keeps their territory. This corroborates our observation that local expertise is sustaining for a territory. Bakker and Bakker-Rabdau's emphasis on showing initiative and taking responsibility may in fact be a very accurate description of the kind of control that participants describe with respect to writing territories.

Given the significance of authorship to territorial functioning in the collaborative writing process, identity becomes important. This parallels Bannon and Bødker's [5] observation that the identity behind information is significant to work in common information spaces. While Bannon and Bødker describe assessment of credibility as a reason for this, our findings highlight the connection between identity and judgments of a person's rights with respect to a given piece of text. Text written by the person in charge of a textual territory has higher status than if written by someone else; it is less easily modifiable. That is, the history of a piece of text has an impact on territorial cognition and thereby behaviors. As the locus for this history the text thus acts as an intermediary object, modulating future work on the text.

As the following participant pointed out, knowing the identity behind a comment helps the writer prioritize:

> '[...] that's one indication, also for other people, to know: Okay, if she wrote that comment in that section that is actually her expertise then it's more valuable, or more interesting or more relevant, than coming from somebody else.' *(G-R06)*

This quote exemplifies both the significance of local expertise and Bannon and Bødker's point about credibility.

The perception of control is also influenced by role division. In many cases, the main author has the final say. By *main author* we mean the person contributing the majority of the content and/or actual writing. In some academic settings, this will be indicated by placing the person's name first on the publication, as was the case for some of our participants. Examples of the main author having (or taking) the final say include these cases of Ph.D. students describing their relationships to their supervisors' feedback on papers of which they are the main and first author:

> 'I've really just gone in and changed stuff, also because I realized that even though he says: I think it should be this way. I can say: "No I don't think so."' *(G-R15)*

> 'I might have times where I just ignore her feedback because I know that I'm trying to push this specific point through the entire paper [...]' *(G-R12)*

In all cases of writing where there was a role division with one author doing the majority of the writing, participants acknowledged the decision-making power as lying with this main author. This fits the image that being the main contributor to a piece of text puts a person in charge of that piece — it simply varies whether pieces of text are considered on the level of paragraphs, sections, documents, or entire projects. In the case where someone is seen as the primary contributor to the document as one unit of writing, this person has the right to overrule the writing of others. In cases where authorship is more equally divided, the case is sometimes a different one, as exemplified in an earlier quote.

This emphasis on the main author is not to say that other kinds of roles do not have an influence. Seniority can, for example, also affect sentiments about editing:

> '[...] with other senior people I think it would also feel strange if I were to just go in and change their text, I think they would feel that's inappropriate.' *(G-R12)*

In this case the right to edit still depends on who is perceived to control that piece of text, but it has to do with their status in general rather than their role with respect to the particular text. It is thus not necessarily based on local expertise but could instead be based on a general expertise.

5.2 Separation and Demarcation

While writing territoriality was frequently constituted in behavior and/ or sentiment, supported by participants' awareness of who is working where, we also encountered materialized territoriality in the form of separation and demarcation of text. By separation we are not referring to the generation of artifacts separate from the working text, such as the backups, notes, and to-do lists which participants also described to us, but rather to the act of temporarily separating the text that one is working on from the rest of the writing.

5.2.1 Separation

Separation can be of multiple forms: White space surrounding a paragraph or a section (made by use of line breaks or page breaks), a separate shared document, or a separate document inaccessible to co-writers. A group of students described that they would be working on each their part of the report and how they would often make a separate document for each section, not gathering them into the final document until later on:

> 'We would sometimes take a section out and then be writing in each our document and then pull it back into the combined document afterwards.' *(G-S01)*

Figure 9 shows an excerpt from this group's document in which a paragraph has been created by copying and pasting, which can be inferred from the fact that the paragraph's collection of revisions consists of only two edits (likely a paste followed by a small edit or vice-versa).

Figure 9: A paragraph created through only two edits, indicating that it was pasted from somewhere else. *[G-S01]*

The motivation for such separation can be the desire for privacy or a more pragmatic need for a space in which to work uninterrupted; the latter may be to be rid of visual distractions or free from co-writers intervening and disturbing one's flow of thoughts. In the case of the above statement from students their motivation was the visual disorientation caused by multiple people editing simultaneously:

> 'Then someone copy-pastes an image in and then the stuff you were looking at, it's suddenly down on the next page, without you noticing. It can be a bit up and down all the time.' *(G-S01)*

Another example of pragmatic motivation would be the impracticality of two writers simultaneously editing the same paragraph. Some of the participants also mentioned how interference from co-writers at inopportune times could disrupt their thought process:

> 'Sometimes a sentence is tough to get out [...] So it has a lot of intermediate states where it's not that good but might be pointing towards something. [...] It can break that process if someone goes in and changes it. [...] It's these kinds of individual processes that can sometimes get messed up if others go in and meddle with what you're working on.' *(G-R10)*

Several participants also described a preference for working in private:

> 'I need my own process [...] I think maybe it's just that it's a process inside the head that's on paper and I need to, just, have that to myself until I get started.' *(G-S02)*

According to Bakker and Bakker-Rabdau, 'privacy is obtained by establishing a territory to which one can retreat from the influence and scrutiny of others' [4, p. 16]. Fitting for the quote above, they state that the most private realm is a person's thoughts. Taylor [56] presents a more nuanced discussion of the distinction between privacy and territorial functioning, but for our purpose here the important thing to note is that writers' desire for privacy motivates territorial behavior. As demonstrated by the quote above there is not always a pragmatic reason behind, but protecting personal boundaries can be another reason for disarticulation [12]. Being disrupted by the presence of others is furthermore similar to Clement and Wagner's [12] example of information overload. Potential disruptions in fact induce territorial behavior in two ways; in addition to being a way to create a space free from disruptions, territorial behavior is also a way to isolate those of one's own activities that may be disruptive to others. Some of the participants described the forming of a personal workspace where they could work in the way that best suited them:

> 'So there are some parts where you take kind of ownership of the document and it's like: I'm polluting it with all kinds of stuff that's for me and I don't care about whether or not it's bothering you!' *(G-R10)*

In many cases writers must rely on co-writers to respect boundaries. Several participants described announcing to co-writers when they were allowed 'into' a territory:

> '[. . .] it takes me a while to get something that somebody else can look at, that I feel comfortable with. So that's why I generally, for those people, I'll do it in a separate section and I try to write it completely and then: Okay, now you can look at it.' *(G-R10)*

This form of enforcement of territories relies on social protocols to a much larger extent than separation of text. Of course the type of enforcement is often somewhere on a continuum: When separation is merely a page break the writer is more reliant on cooperation from co-writers than if working in a separate document, even if access to that document is shared, as co-writers will be separated from the territory to a lesser extent. Social protocols and compliance with these must be achieved through negotiation, whether direct or indirect. By indirect negotiations we are, for example, thinking of conflicts caused by differing opinions regarding rights to edit: As these conflicts surface and are discussed (and potentially resolved), or even just as a result of them even if no one brings up their dissatisfaction, changes in behavior will usually result.

5.2.2 Demarcation

Another way of segregating work is by demarcation rather than separation; that is, by use of signals to mark territories. Such signaling of claims is included in both Taylor's [56] and Bakker and Bakker-Rabdau's [4] descriptions of territories. A page break already borders on being a signal as it does not make a strong material boundary for co-writers and thus relies on compliance. Participants also described using color codes to signify who was in charge of a piece of text:

> 'So in the top of the document we had a color code for each of us. And then we marked each point in that color so that we could see who was assigned what.' *(G-S01)*

These color codes are not necessarily applied on the text itself but are used e.g. in a bullet point list which maps to the different sections or topics to be written (about).

Color codes are also used for identification of the writer, enabling co-writers to know who wrote a particular comment or piece of text:

> 'We have comments in different colors, so we know that the yellow comment is from this author; the red color is from the other author.' *(G-R13)*

Conventions, such as color coding, which are negotiated and mediated through the document provide co-writers with a foundation for cooperation [8]. Through the forming of conventions that manifest in the document, the document becomes an intermediary object that simultaneously mediates the object of work and many of the conventions and interactions supporting the work, i.e. articulation work.

Separation, color coding, and use of macros for identification in general are all examples of writers appropriating the tools to cover needs for articulation work. By adapting their use of and combining features of the tools at hand writers achieve a form of double-level language that allows them to navigate the content, and thus the task, as well as the social context. The color of a bullet point comes to signify both that a task will be taken care of and who will do so, and additionally may signify that this person has certain prerogatives with respect to this task and conversely that others do not have such prerogatives.

5.3 Navigating Territories

From participants' accounts we get an impression of a great amount of social expertise and awareness used to navigate the text as a social space. Participants generally take care not to overstep boundaries. A way to accomplish this is to make use of comments for editing to avoid directly 'touching' other people's work, or to enable the original writer to reverse the decision:

> '[...] whenever they had something written [...] I would always rewrite it as a comment and leave the original thing that they had, cause I wanted them to then approve, right?' *(G-R10)*

Other participants were less reluctant towards making changes directly and were correspondingly more accepting of others changing their own writing. They, however, still had strong opinions regarding the way such changes were made, akin to Birnholtz and Ibara's [6] findings:

> 'I definitely don't think it's okay if anyone ever deletes someone else's writing without explaining why.' *(G-R06)*

These participants described a form of editing etiquette in which respect is shown for the original writer by providing explanations for edits (and conversely

no explanation is disrespectful). This behavior is an expression of territoriality because it is rooted in an awareness of affiliation, ownership and rights with respect to specific regions of text. This is another example of double-level language: The comments in and of themselves contain edits or serve to explain rationale. But what they additionally (and at least as importantly) provide writers is a way to demonstrate respect and maintain social order. While demarcations, such as the color codes described earlier, mainly serve as a kind of *expressive* double-level language that signals expectations, writers use comments to communicate in a way that expresses compliance with such expectations, as such a more *operative* double-level language.

As an extension of the guideline that you do not touch other people's work, many participants who were using real-time editors also reported that they would generally not be editing in the same spots, out of courtesy as well as for practical reasons:

> 'It rarely happened that a person would be messing with something that someone else was still editing.' *(G-S01)*

We have already mentioned similar examples in the preceding sections. What we want to emphasize here is the role of courtesy in writers' decisions. The choice of words ('messing with') indicates the negative connotations of interfering while someone is working.

What is furthermore exemplified in the quote above is the role that timing plays in territorial etiquette. Another participant's statement additionally shows us that timing is a more delicate matter than simply being aware of the co-writer's presence:

> '[. . .] if it's something that's just been written then there's also a bit more ownership of a section, and then you really need to be careful when you change something.' *(G-S03)*

As we see here, it is not always enough that the co-writer is not currently writing — some writers also take into account how recently the co-writer has been working on the text. This significance of timing can in part be explained with Bakker and Bakker-Rabdau's discussion of *action territories* as areas in which a person exercises their expertise. Such a territory depends, according to Bakker and Bakker-Rabdau, on continuous performance of the work making up the territory. In our case, this means that as long as the co-writer is working on a piece of text, that piece of text is considered their territory. Thus, the less likely it is that they are still working on the text, the more likely it is that modifying the text will be acceptable.

5.3.1 Explicit Coordination

In addition to etiquette participants also used more explicit means to coordinate editing so as to avoid intruding on each other. One participant, a Ph.D. student, described a procedure that had developed between him and his supervisor, where his supervisor would 'always wait for a "go"' (G-R12) from him before editing anything that he had written. In this case it was mainly important for the student that they would not be interfering with each other's work and that he would be getting feedback when it was most useful for him. In other cases participants put more emphasis on the writer's ability to control their presentation of self. In the following statement, a participant describes why he and his co-writers would write a message in a group chat when they were done working on a section:

> 'It was out of respect. [...] Let the person finish the thing that he's working on and when he has something presentable he can move on.' *(G-S01)*

As is evident from the preceding quotes, territorial behavior is not always enforced by the person in charge of a territory. Furthermore, there is not always agreement between co-writers as to the enactment of territorial respect. One participant reported annoyance that co-writers would exhibit misguided respect for her territories by suggesting changes in comments instead of just making them directly:

> 'That's usually why I ask people to go over my paper and just say "please, just add it, don't make comments," because it's just a crazy overhead for me. And then they look over it again and they actually make comments, and I say: "No, change it!"' *(G-R06)*

In the end, her co-writers' attempts at courtesy would result in a greater workload for her.

Territorial etiquette materializes in the document, as traces of the different writers. For example, as a participant put it, 'the parts that you have drafted [...] they will never lose this flavor of your words' (G-R12). And during work, writers' awareness of territories is mediated by the document as an implicit reminder of the division of work through section headings, paragraph spacing, etc. The current state of the document ties in with participants' awareness of the division of work, reinforcing social structure and guiding further work. In this way the document acts as an intermediary object by crystallizing the

territorial protocol [8] and, in being the setting of the work, frames the onward writing process.

5.4 Reconciling the Outcome of Fragmented Work

The, for many participants relatively strict, separation of work requires an effort in order for the writing to become coherent and align the viewpoints of its multiple authors:

> 'You have to feel that the text is yours. So that's the thing that I am most afraid, when I write the paper with someone else. It is to find that particular balance of feeling that the text is from both.' *(G-R13)*

Disambiguation plays a core part in collaboration, not only to enable cooperation [8] but also to enable eventual alignment among collaborators regarding their perspective on the contribution.

Statements like the ones presented in the preceding sections show us that territorial functioning is adaptable; closely intertwined with the dynamic writing process. They also demonstrate the negotiable nature of territorial functioning, highlighting the articulation work [50] that is constantly taking place.

And so, despite sentiments of territorial character, writers need to allow others into their territory:

> 'Maybe I came up with a draft, but I should also allow people to make changes and come with different suggestions if they disagree with the content. I don't want them to have their name on the document if they disagree with what's written.' *(G-R07)*

The consequence of this is that writers will, in the end, have had some influence on text written by co-writers, even when there has been acute awareness of territories and consequently enactment of territoriality. Many participants expressed how the text became a shared product through the influence of multiple people editing it. Towards the deadline, territories are no longer strictly adhered to and the editing etiquette falls back in favor of finishing the text:

> 'Maybe if there was a rush at the end and they deleted part of what I wrote, then fair enough.' *(G-R06)*

That writers will impose more on each other's territories in the later phases of writing is something that we also observed in the visual analysis. Figure 10 exemplifies the pattern in which editing is conducted by one writer (the first

three lines in B), until the final editing run when other writers join in (the last two lines).

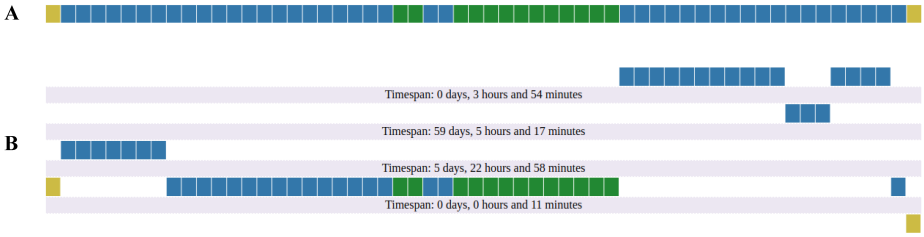

Figure 10: A territory that ended up being edited by multiple co-writers towards the deadline. A) The spatial index visualization, B) The revision chronology. *[G-S04]*

It is still acknowledged that some sections are associated with specific people but there is no time to let work be influenced by this. For example, as the deadline approaches it becomes more important to cut the number of pages to fit the submission requirements than to heed the original writer's right to have a say:

> 'At that point in time then it's just free to go and throw sentences away, and then she does it and then I do it and we don't need approval from the other person.' *(G-R12)*

5.5 Territoriality and Ownership

It is easy to get an impression that territoriality is simply a question of ownership. Document territories and their affiliations emerge through the writing and ownership carries a large significance in the creation of text, as demonstrated by the language used by participants:

> 'It's also the way we talk about it. That we say: That was your chapter and that was my chapter.' *(G-R18)*

This is different from just having an awareness of the division of work. As can also be told from participants' statements in the previous sections they clearly feel an attachment to the text they have contributed, and feelings of ownership are closely tied to the act of contributing, in one way or another:

> 'I did very strongly remember feeling this thing of: It's not my thing. I can't claim this as my paper 'cause [...] I didn't build any of the

> technology, I didn't do the video [...], all I was doing was just editing somebody else's paper — they already wrote most of it.' *(G-R10)*

This participant is describing a project that he joined later than the other collaborators. Joining late made him feel like he did not have the right to claim ownership of the project.

While territoriality can also be related to attachment, territoriality and ownership are not inextricably entwined. For this participant, authorship did not carry the same significance for feelings of ownership as it seems to do for territories:

> 'I feel it's important that one also has ownership of all the technical parts and what's in there [...] and then of course the wording might not be mine, but I think that's not the important part.' *(G-R12)*

She felt an ownership of the writing due to her contribution to the content, despite not having written much of the text herself and thus having no territorial claims to most parts of the document. Similarly, another pair of participants agreed that they each 'feel more responsibility for what I've written but I don't feel like I own it' (G-S05). They felt a joint ownership of the full text despite being responsible for separate parts. It seems like ownership more holistically comprises the entirety of the project, having to do not only with the text but also with the content, the message, and other factors, whereas territoriality is about which specific parts of the text the writer has been working on.

6 Territorial Functioning in Collaborative Writing

The findings presented above paint a complex picture of human interpersonal coordination of digitally mediated document production and editing. This section interprets the findings and their implications for how we may understand collaborative writing. After outlining our understanding of territorial functioning in collaborative writing we discuss some dimensions along which this functioning unfolds by drawing on our analysis and comparing with Taylor's understanding of territorial functioning.

Our findings do not align perfectly with Taylor or Bakker and Bakker-Rabdau's definitions and discussions of territoriality. They, nonetheless, show that we are dealing with a form of territorial functioning when examining collaborative writing. Rather than presenting a new definition, we take territorial

functioning in collaborative writing to be an exemplar of territorial functioning, and we here use Taylor's organizing dimensions to characterize this exemplar (see Table 3). We discuss each of the dimensions below.

MAKEUP *behavioral* ↔ *cognitive/affective*	**Cognitive-affective:** Closer to the cognitive-affective end of the spectrum, as the behaviors we have uncovered are grounded in writers' sentiments about particular regions of text, as opposed to being determined by the material and social context.
INTERPERSONAL FUNCTION *cooperation* ↔ *power*	**Cooperation:** In the cooperation end of the spectrum as the things at stake for writers are relationships to co-writers (getting along and avoiding conflict) rather than establishing dominance. The power dynamics at play in collaborative writing, although influential, are not a central source of territoriality.
LINKAGE WITH PLACE *place-dependent* ↔ *social/cultural*	**Social:** Near the social end of the spectrum, due to the large influence of roles and relationships on territorial behavior. Behavior around a certain part of the text is not due to particular characteristics of that piece of text but to writers' roles with respect to it.
EXTENSIVENESS *limited* ↔ *unlimited*	**Unlimited:** Extension ranges from local and/or temporary to the full document and/or permanent.

Table 3: *Writing territoriality* along Taylor's organizing dimensions.

6.1 Makeup

As described, territories in writing may consist of multiple semantically, or logically, connected pieces of text that do not occur consecutively in the document. Their status as someone's territory is highly dependent on writers attributing this meaning to them, along with certain expectations regarding behavior. The same is true for territories consisting of only one block of text, despite the dependence on meaning attribution and interpretation sometimes being less obvious. In order to construct and maintain a common information space, writers must thus agree on the territorial meanings of the various parts of the text, reflecting Schmidt and Bannon's [49] point that cooperative work requires the negotiation of meanings of shared objects in the common information space. Hence, writers' behaviors are determined by their perceptions and interpretations. This places territorial functioning in collaborative writing closest to the cognitive/affective end of the spectrum; although not completely in one end as negotiated behaviors are significant for sustaining the territorial division of the work.

6.2 Interpersonal Function

The cases of collaborative writing studied in our analysis rely on writers' expertise in navigating the text as a social space. The writer holding the initiative has the liberty to make alterations as they see fit while other writers will employ various means in order to leave the initiative with the original writer. Maintenance of territorial division in collaborative writing is a joint accomplishment that relies on this form of respect for territories. We thus view territorial functioning in collaborative writing as a mutual maintenance of task-related and social functioning. An interesting example of this reciprocity is how maintaining a territory of one's own was described by some participants as a way to avoid bothering co-writers with one's messy work. In sum, we classify territorial functioning in collaborative writing as oriented towards cooperation as opposed to power. While power relations do play into territorial functioning, this seems to serve the purpose of maintaining social order *in order to cooperate*.

6.3 Linkage With Place

We find territorial functioning in collaborative writing to be socially determined as opposed to place-dependent, since expectations based on writers' roles with respect to a given piece of text are the central factor. We have also described how writers achieve a form of local expertise in their territories which factors

into the continued attribution of the status as a territory. The importance of roles and the related expectations supports our understanding of territoriality in collaborative writing as socially determined as opposed to dependent on particular characteristics of the various pieces of text as metaphorical places.

6.4 Extensiveness

We have chosen to refer to Taylor's fourth dimension simply as *extensiveness* as opposed to *spatial extensiveness* since the behavioral aspect of territorial functioning in collaborative academic writing introduces a temporal dimension in addition to the spatial one. Since Taylor's conception of extensiveness hinges on his focus on territorial functioning in physical space, we have to abandon Taylor's physical terms in order to discuss extensiveness in collaborative writing.

As previously stated, territories lie on a spectrum of permanence. In one end of the spectrum, we have territories that continue to be associated with a particular writer throughout the project and may continue to be so after the project has been completed. In the opposite end, the significance of timing becomes clear, as exemplified by the temporally local form of territoriality in which a writer's presence in a section of text causes other writers to leave that section alone. Similarly, on the spatial spectrum, one writer may be in charge of the entire document, effectively having all of the text as their territory, or a person may (possibly temporarily) be in charge of just a paragraph. In conclusion, both the spatial extensiveness and the temporal extensiveness of writing territories are unlimited in the sense that they can range from brief and/or very small to permanent and/or the full document.

6.5 Dimensions of Collaborative Writing

To contextualize our understanding of territorial functioning in collaborative writing, we here discuss some dimensions that have frequently been addressed in work on computer-supported cooperative work, namely time, place, and roles. Time has been discussed with respect to duration [15] or synchronicity [22, 34], while place is typically viewed as (physical) proximity or distribution [15, 22, 34]. Role has mostly been addressed with respect to collaborative writing [47, 3, 44, 45]. In addition to these, we discuss *state* as a dimension.

6.5.1 Time

Synchronicity as the way of speaking about time in collaborative work is of limited value in our case. It says nothing about the object of work despite the

close integration of work on the common object with timing and place. For instance, what participants construe as acceptable behavior is highly dependant on the stage of the writing as well as on who is currently editing and on planned future work. To simply speak of synchronicity would be to ignore the significance of stages and planned work, which critically affect territorial behaviour: Territories evolve through the phases of a project and the working norms for territorial functioning adapt, e.g. to the approaching deadline. Late in the process, as time becomes pressing, previously unacceptable behaviour becomes necessary and happens without disputes. Although the lifetime of territories can extend throughout the duration of the project, the degree to which work is structured around them thus varies with different phases of work. This shifting behavior influences the meaning that writers attribute to the text, meaning that acceptable behavior can be a question of timing.

Timing according to the phases of the writing is somewhat long-term while the timing of interpersonal exchanges happens on a more short-term basis. And timing clearly has an impact on the kinds of interactions that may take place between co-writers — for example, quick deliberation about changes versus leaving an explanation so as to avert negative interpretations by a co-writer in one's absence [6]. Short-term timing, such as when previous changes to a section were made, also influences the acceptability of edits. This timing can also be related to place; whether or how a writer makes an edit can depend upon where co-writers are currently working and when they might see the change. The importance of timing derives, in part, from writers' desire to demonstrate accordance with territorial expectations.

To speak of *timing* seems to better capture the nature of the writing process; the timing of different actions with respect to each other; the timing of presence; the timing of work to the state of the object and the stage of the project. Aiding writers in timing their work to each other and to the object of work would provide wholly different support than merely facilitating multiple modes of synchronicity.

Time is lacking in Taylor's definition, something he in fact remarks himself [56, ch. 14]. He briefly discusses how the adaptive nature of territorial functioning relates to time, but this does not come close to the temporally dependent changes to territorial functioning that we have described in our discussion of progression towards the deadline. Furthermore, Taylor does not mention timing at all.

6.5.2 Place

Place in computer-mediated collaborative writing has multiple levels. We may talk about writers' physical location with respect to each other, as well as location within the text at multiple granularities: document, file, paragraph, section, topic, the latter of which is solely manifest in writers' minds, due to their unspoken awareness of which parts of the text are logically connected. It is the in-text place that is relevant to our discussion.

Taylor [56] is solely focused on place in a physical sense, such as physical layout and its connection with territorial cognitions and behaviors. He explicitly argues against a 'despatialization' of the concept [56, p. 321]. The term *territorial* applied with respect to ideas or projects is, according to Taylor, used metaphorically. However, permitting the metaphorical application of the concept without opening up to different forms of territorial functioning seems simplistic. As we have argued, a metaphorical view of collaborative writing as taking place in a virtual *space* makes good sense.

Territorial functioning in collaborative writing is not mainly determined by 'physical' characteristics of the text and the editing environment. Rather, what has significance are affiliations between writers and parts of the text, and how writers place themselves in the virtual space. There is a great deal of contextual dependence at play in this: Whether the writer of a piece of text is currently present, whether the text is still a draft, and whether the project is at an earlier or a later stage all influence how writers and co-writers interpret the situation and each other's actions. Place and timing are thus closely related.

The physical metaphor does not apply to writers' attachment to the text. While Taylor's concept of attachment is linked to familiarity with a place over time, attachment in collaborative writing is between the writer and their creation. Both kinds of attachments carry with them a desire to remain in control, but it is the writer's attachment to the text that is significant for territorial functioning in collaborative writing.

6.5.3 Role

Part of territorial functioning is the association of certain people with certain places. In collaborative academic writing, the association between people and text stems from roles with respect to the project and the assignment of tasks, as well as the ensuing work which is what actually ties writers to certain parts of the text.

As in Taylor's description of territorial functioning, cues about role 'help

set the 'tone' of the interaction, and shape expectations about its outcome' [56, p. 216], but in our case the expectations regard modification (or not) of the text in question, as opposed to expectations regarding general interpersonal interaction. The territorial functioning of collaborative writing in a way comes down to activities that are associated with roles and assigned tasks. It should be stressed that these roles are not static: Users continually shift between writing, proofreading, planning, deliberation, and so on, as they relate to each other and each other's work during the writing.

Different constellations of roles entail different forms of acceptable behavior [4]. For instance, if a writer has announced that their text is ready for feedback, a new role has been offered their co-writers in which they are allowed to 'intrude'[1].

6.5.4 State

As mentioned, the state of the text is another dimension to be considered. The document as an intermediary object supports social functioning and cooperation by continually mediating the division and accomplishment of work [8]. Writers occasionally produce concrete separate instances of the text in the form of drafts, backups, bullet point plans, etc. But even more so, the actual document's current state acts as a mediator for its own continued production. The various instances of this same document, along with separate versions and notes, make up intermediary objects that influence the way it is worked upon beyond simply being the foundation for the next addition. Writers' awareness of territories is mediated through the document and they interpret the state of the text in order to act usefully and appropriately, such as by inferring whether feedback on a piece of text would serve as a helping hand or a disturbance. Such inferences of course also rely on awareness of the given co-writer's preferences and ways of working, but the interpretation of the immediate situation relies on information to be read from the current state of the text.

The counterpart to interpretation of state is the articulation of conventions and of the work, which partly happens through territorial demarcation. Taylor, likely due to his physical perspective, focuses on ways of signaling that something is a territory and whose it is. In the presentation of our findings we have additionally discussed writers' efforts to signal compliance with territorial expectations. This particular aspect of territorial communication plays a significant social role which Taylor's definition does not cover. Addressing writers'

[1] This interpretation is more dynamic than the one by Bakker and Bakker-Rabdau which focuses only on situationally dependent roles such as teacher/student.

needs and means for articulating themselves and the work is central.

The granularity of state is difficult to specify. In the case of territoriality it is whatever carries meaning to the actors involved and influences whether and when they work on different parts of the text. This obscurity makes it no less of a significant factor in the interpersonal dynamics of collaborative academic writing. The challenge lies in identifying an actionable takeaway: How do we design for states as intermediary objects?

6.6 The Activity of Collaborative Writing

Some classifications of cooperative work take a perspective in which the collaboration is categorized based on characteristics of the group and the work context. We propose instead to view collaboration in terms of the transitions that take place; between people; between stages of writing; between different places; between shared and withheld; as well as the timing of transitions and interactions and what these mean for social dynamics. Focusing on classifying the collaboration according to characteristics of the group and the mode of collaboration enforces a static view that may result in a poor match between the classification and reality [22]. Emphasizing activity over classification serves to place focus on how the collaboration is and can be mediated.

Of course, a characterization of the group in terms of, e.g., roles and hierarchies may be useful for such an analysis. What we mean is that such a characterization in itself does not say much about the activity of writing.

7 Discussion

The findings and analysis above highlight the conscious strategies and non-contemplated routines that people apply to make cooperative work function. Most of the examples presented highlight what makes a collaborative academic writing endeavour successful (or at least functioning) in a group dynamics perspective. This is not to imply that present-day collaborative writing has the perfect conditions. The bias in our findings toward stories of what makes group work function as opposed to what breaks it is likely in part due to well-functioning groups being more likely to sign up for a study like ours. Bad writing collaborations do occur (probably frequently); several participants related current experiences to other often less well-functioning collaborations. One source of conflict is misalignment in territorial functioning, such as misaligned expectations regarding behavior around other people's text which then leads

to boundaries being overstepped. The document's role as an intermediary object in this case becomes that of mediating the expectations and opinions that co-writers bring into the collaboration, so that new, shared conventions can be established [8]. This mediation is ongoing, even after the establishment of conventions [38] and no matter if the collaboration is or becomes well-functioning or not.

Our findings are grounded in 23 interviews and the quotes presented have been selected from all of these. However, the visualizations come only from a subset of the people we interviewed and we cannot know whether visualizations of the remaining collaborative documents would also confirm what we have found in the interviews, although we expect that they would. Furthermore, we have only been able to conduct the visual analysis on Google Docs documents, despite participants working in other tools offering to give us access to their documents. We suspect that we may find subtle differences between Google Docs documents and Overleaf projects, to take an example. Future work in this direction could shed light on how various writing tools may influence the collaborative process in different ways.

Only having visualizations of documents written in a real-time tool may also have skewed the analysis to focus on findings relating to this form of collaborative writing.

This study, furthermore, presents collaborative writing in a particular setting, namely academia. By focusing on academic writing we have been able to interview a sample of people which covers that type of writing better, but which does not represent the wider spectrum of collaborative writing. It is likely that some findings will carry over while others, such as the emphasis on the main, or *first*, author for some groups, may be specific to academic writing.

7.1 The Social Collaborative Writing

The work presented here adds to the corpus of empirical work documenting social workings of collaborative writing, such as Birnholtz and Ibara [6] and Wang et al. [62]. We extend their work by framing those social workings as territorial functioning. This framing jointly explains both Wang et al.'s findings on writers' desire for privacy and Birnholtz and Ibara's findings on the relational effects of edits. It has, furthermore, helped us to identify the significance of timing and local expertise to both of these.

Taylor's understanding of territorial functioning de-emphasizes power dynamics in favor of a wider focus on all sorts of social dynamics. This means

that our analysis, akin to Cerratto-Pargman [11], focuses on social motivations for sustaining good relationships with co-writers as opposed to the potential significance of hierarchies, power structures, and predefined roles, although we acknowledge this dimension of collaborative work. Wang et al. [62] present a much a more hierarchical view of the collaborations in their study.

7.2 Territorial Behavior and Motivations

Thom-Santelli et al. [57] describe writers' motivation for secluding their work as a drive to remain in control. We have described different and more diverse motivations, such as making sure that feedback is provided at an opportune time. Active monitoring of articles, which Thom-Santelli et al. describe, is not something we have encountered and may, in combination with the emphasis on being in control, highlight a central difference between long-term collaborative maintenance of online writing on Wikipedia and collaborative academic writing towards a deadline. This difference is also evident when Wikipedia maintainers' desire to avoid tampering by other editors is contrasted with the academic writers in our study striving for everyone to feel ownership of the text in the end.

Wang et al. [62] describe motivations similar to some of the ones expressed by our participants, such as privacy and distractions, but Wang et al. simplify their description of the resulting behavior to writers using Microsoft Word for asynchronous work and Google Docs for synchronous work. Our findings show that the dynamics are more intricate than that; involving respect for co-writers' demarcations and personal space in the text.

Counter to our findings, Olson et al. [45] report that their participants would freely edit each other's text, which they take to be a sign of trust. The collaborations studied by Olson were short-term (less than two days) and although we, too, find it likely that trust may influence editing behavior, we find it odd to assume the development of trust in such a short-term collaboration, particularly given that Olson et al. do not specify whether participants knew each other or had worked together before. Given our findings and discussion of territorial functioning above, it may be that Olson et al.'s participants did not feel as attached to their produced text as some of our participants, considering the difference in project duration. Another possibility is that the work in Olson et al.'s study took place so close to the deadline that their participants simply adopted a less territorial way of editing from the start.

7.3 Writing Strategies

Although it was not part of our focus, we have from our interviews and cursory overview of the visualizations noticed patterns similar to some of those described by, among others, Yim et al. [63]. Although we do not discuss them in terms of writing strategies, our findings regarding the evolution of territorial functioning towards the deadline adds to the work by Yim et al. by highlighting the transitions between different styles of writing. This is likely due to the longer duration of the writing projects we have studied.

7.4 Ownership

Ownership is a recurring theme in much of the work on segmentation and interpersonal relationships in collaborative writing. Mockus et al. [39] describe code ownership; however, emphasizing that this ownership gives the 'owner' more respect but not additional (formal) rights with respect to the code. In that case, we find that ownership as a concept does not add much analytic value.

As we have argued in our analysis, although ownership and territorial functioning are closely related they are not the same thing. Birnholtz and Ibara [6] likewise state that respect for co-writers' opinions on work that is theirs or which they have a stake in is about more than ownership in that it has a 'distinctly social element'[6, p. 813] to it. The same can be said about the respect that Mockus et al. [39] describe.

We argue that territorial functioning and ownership are two different lenses. Ownership in collaborative writing or coding says something about the individual's or the group's relationship to their own creation, while territorial functioning says something about the interpersonal dynamics surrounding the creation (for instance, behaviors resulting when someone intrudes on what is perceived to be someone else's territory).

7.5 Collaborative Writing as a Fragmented Exchange

The ability to withdraw or to manage boundaries puts writers in control of their current activity, including how co-writers may affect it, which in turn enables them to more freely carry out that activity [56]. As Clement and Wagner [12] put it, regionalization can help the individual writer focus and protect their view, so as to build the text through their local expertise without undue interference from co-writers.

Fragmentation of the writing also facilitates necessary coordination among

writers. The elaboration of the text as a common product depends on this coordination of writers' local production and expertise along with processes of integration [11]. This is reflected in other findings, such as Yim et al.'s [63] observation that a 'divide and conquer' style of collaborative writing produced better text than other styles.

The reason that collaborative writing becomes a fragmented exchange can be put simply as people needing space and time to do their work. Despite collaborative writing being centered around one, common object of work it usually involves a large degree of separation, as previous identifications of document production strategies in collaborative writing have shown [47, 3, 63]. Our contribution with this work has been to characterize the nature of this separation. While the aim of this study has not been to determine whether fragmentation is beneficial to the outcome of collaborative writing, we will stress that territorial functioning is part of the inevitably social nature of collaborative work and is not inherently dysfunctional. In settings discussed by Clement and Wagner [12], zoning of work does not necessarily hinder or impede its accomplishment. Likewise, fragmentation itself does not appear to be disruptive of collaborative writing. Tying together the contributions from multiple co-writers requires effort [63], but our participants are clearly aware of this and are able to accomplish it. Rather, disruption occurs when tools do not adequately support the natural interaction patterns of territorial functioning.

8 Implications for CSCW

Current solutions do to a certain extent support writers' articulation work, as exemplified through the instances of double-level language presented in our findings. However, this is to a large extent achieved by users themselves through appropriations of the tools.

In Robinson's words, drawing on 'the power of human dialogue and imagination' applications should 'ground and focus' writers' cultural language [48, p. 55]. This cultural language rests on unspoken awareness and navigation of territories. But while we advocate thinking about tools for writing as double-level languages when designing them, designers should be careful not to transform users' articulation work into explicit declarations of the work. For example, a design that take the many possible roles at play during writing into account should not hinder writers' natural transitions between roles by demanding that they explicitly declare and switch roles. As Olson et al. state, a collaborative writing tool should allow writers to 'creatively and flexibly use the tool without

declaring what activity they are performing' [45, p. 29].

8.1 Awareness and Timing

Allowing people to socially navigate common information spaces requires support for the timing of actions on a moment-to-moment scale. Some of the early work on tools for collaborative writing describe project management features [19, 47] which can be seen as support for timing on a larger scale. Timing on a shorter-term scale requires a common awareness of the work as it is in the moment.

Considering the role that timing plays for the acceptability of edits, a solution could involve visualizing the recency of each writers' editing activity in all parts of the document, split into small segments, as a form of 'heat map'. This would enable co-writers to interpret the timing of activities (and thus which parts of the text have been edited at the same time and are likely logically connected) as well as to time their own editing according to the state of co-writers' contributions. This idea is similar to Hill and Hollan's [28] graphical depictions of edit activity in the scroll bar of a writing application.

As an extension of the idea that writers could indirectly infer logical connections in the text from heat maps, another suggestion would be to allow users to specify links between different parts of the text, in a way providing an explicit mapping of local expertise that would help co-writers avoid or follow up on edits that may negatively affect the coherence of the text. Such a feature should not aim to replace writers' awareness of local expertise but could, for example, support it early on in a project when writers may not yet have a good overview of the text. Furthermore, creating such links should of course not require a disproportionate effort for co-writers. Gehrmann et al. [20] describe preliminary work on automatic detection of changes and which paragraphs they may cascade to in a collaboratively authored document. This may be an alternative approach to mapping local expertise.

8.2 Private Spaces

The practice of separating work has many motivations but comes down to a desire for a space over which the writer has more control and, in some cases, privacy. The workarounds that writers currently apply to achieve this decouple their work from the common work process and from the object of work. As both social and practical aspects of the process rely on writers' interpretations of the current state of the text, this decoupling is undesirable as the shared content

does not reflect the actual state of affairs.

Recommendations for private workspaces in collaborative settings [14, 16, 44] have been overlooked for a couple of decades and have yet to find their way into publicly available systems. Wang et al.'s [62] recent work has revived the idea and we support this. In software development, a different field concerned with the production of text, separation of individual work has become a natural part of collaborative work [13], mediated through the use of version control systems. But while version control systems seem to, by and large, fare well when used in software development, this model seems too restrictive for collaborative academic writing. Facilitating both articulation and disarticulation requires that transitions between the two be made easy (as also pointed out by Cerratto-Pargman [11]). We also wish to caution that disarticulation should not be accomplished by decoupling private activities from the shared work. A design challenge lies in allowing disarticulation *in place*, in a way that supports contextual awareness. This could also allow writers to balance the need for disarticulation with the need to signal to co-writers that they are currently working and potentially what they are working on [29, 62]. This would be helpful for both coordination and relationships between co-writers.

8.3 Disarticulation and Ambiguity

Clement and Wagner [12] argue that communication spaces should permit zoning through rearrangement, drawing an analogy to physical space. There is a problem in this spatial metaphor: While physical arrangements are usually due to an assortment of needs and incidental occurrences, this is less frequently the case in computer-mediated information spaces. It is not as easy to casually bring something out of collaborators' view without it calling attention to the disarticulation that is taking place. In other words, computer-mediated common information spaces do not present the same possibility for ambiguity that physical space does. In addition to facilitating awareness of the current state, we therefore urge designing for ambiguity, a vital means for the management of interpersonal relationships [1, 7].

9 Conclusion

Based on a mixed methods study we have presented findings that outline the role of territorial functioning in collaborative writing. Territorial functioning of this kind is socially motivated and serves to develop and maintain social structure for

cooperation. Writers' territorial cognition and resulting behaviors are mediated by the object of work itself, which thereby feeds into the simultaneous, ongoing processes of producing the text and negotiating the collaboration. That the tools in use are able to act as double-level languages is important for the interpersonal functioning involved in this.

Our findings suggest that the interpersonal dynamics, of which territorial functioning is an example, require a rethinking of the way we frame collaborative work as a design challenge. Currently, the central problem to be addressed is usually conceptualized as the work situation, given by the physical context and the mode of collaboration. This understanding does not enable us to support the social needs that people bring with them from other aspects of social life into digitally mediated collaborative work. We see potential in framing the problem in terms of the transitions required for articulation and disarticulation of the work. This includes the timing of actions and interactions, which are essential in the enactment of social etiquette. Since collaborative work is by nature a social endeavour, these interpersonal aspects cannot be ignored.

We suggest that designers of collaborative writing tools consciously aim for tools to be double-level languages. Designs should also strive to support the timing involved in territorial etiquette by facilitating awareness of the current state of the text. Finally, disarticulation should not require writers to provide rigid declarations about their current work situation, it should not decouple writers from the collaborative situation, and it should support socially sustaining ambiguity.

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