
Examining the Differences of On-Tabletop and Off-Tabletop Personal Territories in Collaborative Interaction

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Abstract

In this work in progress paper, we present first results of a collaborative tabletop study that compares different types of territories. Our research focuses on interaction with digital objects (post-it notes) during a brainstorming task in two conditions: In the first condition, the creation of digital objects took place on a large scaled tabletop screen – no delimited territories. In the second condition, mobile personal spaces (personal tablets) were used for the creation of digital objects. In both conditions, the tabletop was used for collaborative organization of the created digital objects. Based on a total of 20 groups, we report qualitative results about different territorial strategies during the observed brainstorming sessions. Furthermore, we discuss the dynamic positioning of the participants at the tabletop during collaborative work.

Author Keywords

Tabletop; tablet; collaboration; territoriality; personal space; social interaction

ACM Classification Keywords

H.5.3. Group and Organization Interfaces – Collaborative computing, Synchronous interaction.

Study structure

Training: Firstly, the participants familiarized themselves with the interfaces.

Task presentation: Following training, the participants individually read the task and completed a first questionnaire.

Individual creation phase – 10 minutes: The participants generated individually ideas for 10 minutes directly on the tabletop in condition 1 or on the personal device in condition 2.

Collaboration phase – 35 minutes: Thereafter, they worked collaboratively for 35 minutes on the task. The participants were asked to further collaboratively generate ideas and to prioritize the most important 6 ideas.

Questionnaires: Finally, the participants answered a final set of questionnaires.

Introduction

Previous research has shown that tabletop users usually partition the workspace into different types of **territories** and that territories play an important role for coordinating multi-user activities and for mediating group awareness [4, 6]. Furthermore, it has been shown that people working at the same table prefer different **spatial arrangements** [6] depending on the task at hand. Specific spatial arrangements influence the orientation of digital objects on the table. The **orientation** of digital objects is considered to play an important role in tabletop collaboration [2]. Beside the use of a tabletop as a shared device, newer studies [7] have investigated the interplay of **shared** and **personal devices** and the transfer of digital objects between these devices. In this paper, we focus on how people naturally coordinate their activities at an interactive tabletop, what kind of special arrangements they create and how they orient their digital objects depending on the type of territories offered to them.

To assess this influence, we developed a real world scenario task that can be assigned to the class of creativity tasks according to McGrath's task circumplex [3]. During this task, participants are asked to generate ideas that are represented on the tabletop as digital objects (post-it notes). These post-its serve as **interactive external representations (IER)**, defined as representations that can be easily modified or changed by an agent [5]. IERs can play different roles during tabletop interaction on both individual and group level. They have been shown to constitute resources for internal cognitive processes at individual level and to mediate communication at group level [5]. In this paper, we will relate the role of IER to the topics: territoriality, spatial arrangements, and orientation.

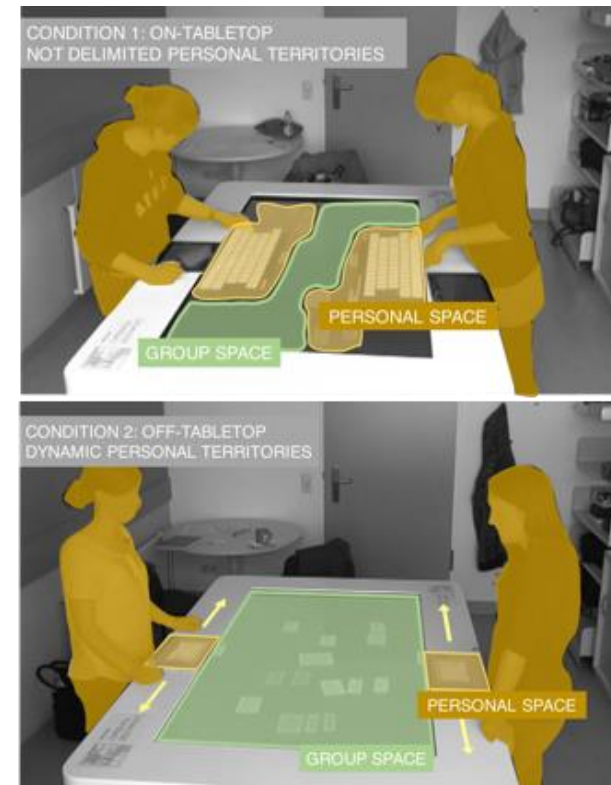


Figure 1: Study conditions

Study

For this study, a realistic collaborative brainstorming task was developed. The participants were asked to collaboratively generate innovative ideas to support productive work for a flexible office of a fictive university. In addition to clarifications with respect to the meaning of productive work, the participants were provided with a description of employees' requirements for the office and employees' activities. The task had two phases: an individual phase and a collaborative

Demographic Data

40 students were prior randomly assigned to the conditions presented in this paper (27 female; average age 23.68). During the experiment they worked in pairs, with 20 pairs in each condition. The participants had different backgrounds.

phase. During the individual phase, participants individually generated ideas. The collaborative phase immediately followed the individual phase and consisted of further generating ideas and prioritizing the six most important ideas. To solve the task the participants worked in pairs at a tabletop system – see Figure 1. The used interactive tabletop system was based on a 65" touchscreen with Full HD resolution. Besides that, participants were also provided with personal tablets (MS Surface Pro 3).

The study compares different types of territories. The conditions presented here are further differentiated by the post-it creation method. In the first condition, *on-tabletop not delimited personal territories*, the creation of the digital objects during the individual phase took place on a large scaled tabletop screen (see Figure 2). In the second condition, *off-tabletop dynamic personal territories*, tablets were used for the creation of digital objects during the individual phase and thereafter they had to be transferred to the tabletop for the collaborative phase.

In the *first condition*, an on-screen keyboard for text entry was provided on the tabletop. By pressing an add-button the text entry was placed as a post-it object (IER) randomly on the screen. An initial random placement of digital objects was chosen to avoid a system proposed territorial organization. Each participant was provided with a tablet. In this condition, the tablet was only used to display the task description and to fill out questionnaires. In the *second condition*, the participants used the tablet for text entry in the individual phase. Text entries on the tablet were displayed in a list. Each text-note could be transferred to the tabletop individually (a share-button was available for each entry). Furthermore, multiple notes

could be transferred at once by selecting an assigned checkbox. A check-all option to transfer all IERs at once was also implemented. During the *collaborative phase*, the participants in this condition could choose between text entry on tablet or tabletop.

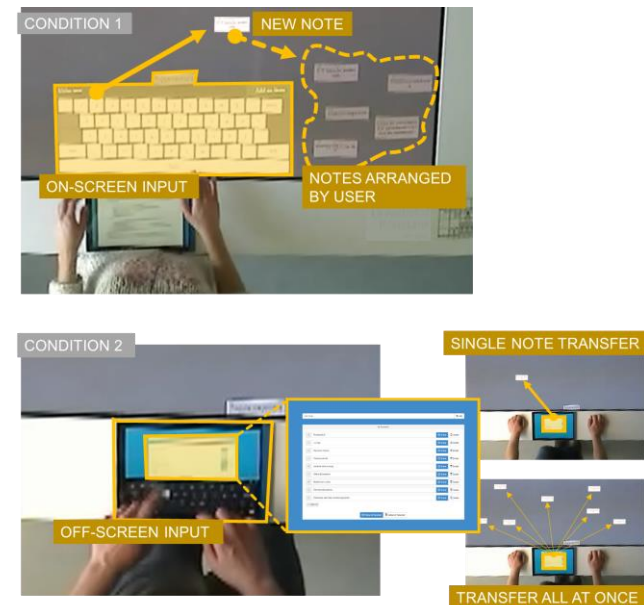


Figure 2: Detailed condition description

Territoriality

Recent work on territoriality proposes a distinction between three types of territories: personal, group, and storage territories. These territories are created organically by users through the positioning and orientation of artifacts (IER) on the surface [6]. Personal territories are established directly in front of the user and are used for manipulation, editing, and reservation of resources. Meanwhile, group territories

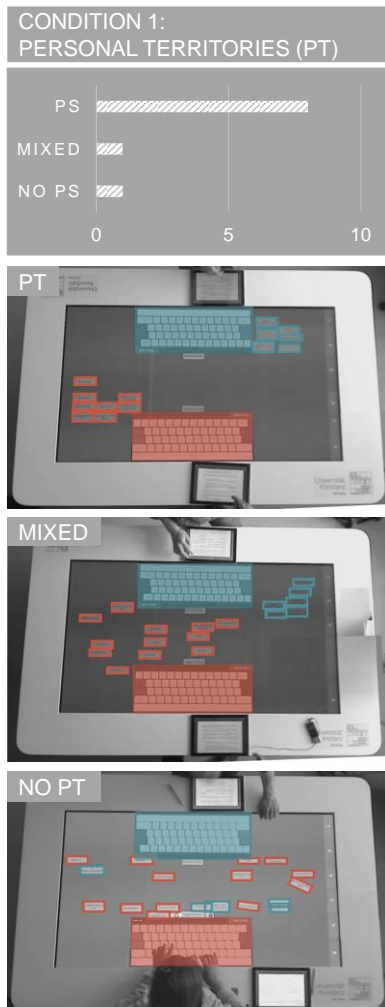


Figure 3: Types of Personal Territories in Condition 1

provide context for the group task and hold shared artifacts.

In this experiment, we observed territorial behaviors consisting in a series of changes in the spatial arrangement and orientation of IERs during collaborative brainstorming. Based on observations, we consider that territories are not static areas that permanently exist, but states of spatial arrangements continually changing during the collaborative activity. It seems that the (re)arrangements of the IERs and of the participants' spatial position with respect to the common artifacts play an important role in group coordination. We call this type of behavior **territorial flow**. In the analyzed task, the territorial flow started with the creation of *personal territories* and moved toward creation of a *shared external artefact model*. Below we give some examples of territorial flow through arrangements and rearrangements of digital notes, orientation and re-orientation of digital objects, and users' spatial repositioning with respect to the common artifacts.

Coordination through (re)arrangements of digital notes into personal territories

In *on-tabletop not delimited personal territories condition*, 8 of 10 pairs clustered their text-notes in **personal territories** (fig.3-PT-) during the individual phase – see Table 1. Only one pair did not display any territorial behavior in this condition. None of the participants in this group organized the IERs at all, i.e. they left their notes nearly untouched as they were arranged by the system (fig.3-NO PT-). In the other pair classified as not displaying territorial behavior, one of the participants did not display any territorial behavior, meanwhile the other participant displayed a more and more territorial behavior (fig.3-MIXED-).

Only 4 of 10 pairs in the second condition, *off-tabletop dynamic personal territories*, established personal territories on the tabletop, additional to the personal territory offered on the tablet. In this condition, all notes were entered in the individual phase on the personal tablet and transferred to the tabletop thereafter. We observed two different overall spatial arrangements strategies depending on the used tablet-table transfer method: all in method and sequential transfer method.

One half pairs (5 of 10) transferred all items **at once** from the tablet to the tabletop (*all-in strategy*) – see Table 2. The other half of the groups transferred their notes **one by one** (*sequential strategy*). The groups that used the *all-in strategy* showed a stronger territorial behavior (see figure 4). They reorganized all transferred IERs by changing their position and orientation. This can be explained by the fact that transferring all items at once leads to a cluttered screen since each note is randomly placed on the tabletop by the system. Interestingly, immediately after the transfer 4 of the 5 pairs established a personal territory on the tabletop by positioning their notes near to them. Meanwhile the groups that used the sequential strategy tended not to make use of personal territories on the tabletop.

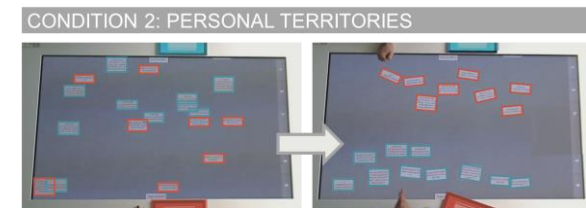


Figure 4: Example. Establishing personal territories on the tabletop. A: Random arrangement of the notes on the table. B: Personal territories created by the two participants

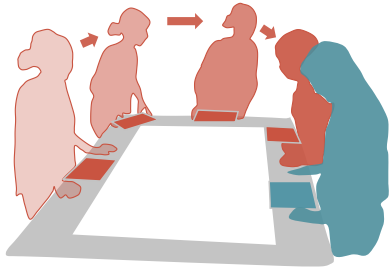


Figure 6: Changing spatial position to side by side arrangement

The establishment of personal territories is not necessarily an individually carried out activity. We observed that participants' territorial behavior was not restricted to their own notes. While creating their personal territories after the notes transfer from the tablet to the tabletop, an unsolicited help from the other participant was often observed.

Coordination through (re)orientation of digital objects

After establishing personal territories, all groups except of one in the non-territorial condition merged their personal territories and created what we call a *shared external artefact model*. A shared external artefact model was defined as a meaningful clustering of all IERs generated during the individual and collaborative phase. Some groups started this process (territorial flow) by changing the orientation of their IERs (see figure 5). Thereafter, they mixed their IERs one by one until they came up with a final arrangement that could be described as a group space or a shared external artefact model. The creation of this model seems to be intrinsic to solving the task collaboratively – 16 of 20 pairs showed this behavior. We consider that this model bears a great importance for the collaborative work, especially since it was not required by task instructions and yet several groups created it. During the creation of the shared external artefact model, some pairs set up a shared layout oriented to the short side of the tabletop. Such a layout allows an equal perspective for both participants on the tabletop.



Figure 5: Changing orientation of IERs

	Non-territorial	Delimited Territories
Personal territory	8	4
Shared external artefact model	7	9

Table 1. Number of pairs that coordinated themselves through rearrangements of digital notes

Coordination through participants' spatial (re)positioning

We noticed differences with respect to participants' spatial positioning both between experimental conditions as well as between pairs using different transfer strategies. The participants started in a **face-to-face arrangement** and had a standing position during the experiment. They were not instructed with respect to their spatial position at the tabletop. We considered the standing position to be more inviting for freely choosing the most appropriate position during the collaborative work, which also seems to have been the case. In the *off-tabletop dynamic personal territories* condition, half of the pairs repositioned themselves during the collaborative phase compared to only one in the *on-tabletop not delimited personal territories condition*. With respect to the transfer strategy, half of the groups in the *off-tabletop dynamic personal territories* condition used a *sequential transfer strategy* – both participants added their IERs one by one on the tabletop (see Figure 7). Worthy to note is also that 4 of 5 pairs that preferred this strategy also changed their position at the tabletop to establish a **side-by-side arrangement** (see figure 6). This is even more interesting considering that only 5 of 10 pairs changed their position at the tabletop in this condition and *almost all of them* (4 out of 5 pairs) followed the *sequential transfer strategy*.



Figure 7: Side by side - sequential

Based on these observations we consider that coordination also takes place through participants'

	Non-territorial	Delimited Territories
All-in transfer	<i>Not applicable</i>	5
Sequential transfer		5
Face-to-face	9	5
Side-by-side	1	5

Table 2. Transfer strategy and spatial repositioning

spatial repositioning at the tabletop. Changing the spatial position offers participants the advantage of having the same perspective towards the digital artifacts on the tabletop as well as on the personal tablets. The items on the tabletop can be easily reoriented so that both participants can easily read them. At the same time, a side-by-side arrangement has also drawbacks: Interpreting the repositioning in a side-by-side arrangement in terms of Hall's concept of proxemics [1], we observe that repositioning oneself in a side-by-side arrangement, the participant has to enter the personal zone or even the intimate zone of the other participant. Participants have to move closer together and must give up the direct face-to-face arrangement that that better preserves their intimate zones. The influence of tabletops as environmental settings on interpersonal distances has been little studied, however it seems to bear importance in the orchestrated collaborative teamwork that needs to be further explored.

Conclusion

In this study, we have examined how territories are intrinsically created. We observed different spatial partitioning of the tabletop as well as two different type of positioning at the tabletop between the conditions reported here. In detail, participants in the first condition, *on-tabletop not delimited personal territories*, exhibited stronger territorial behavior by establishing more often personal territories on the tabletop and holding on to their initial position at tabletop (face-to-face). Our observations suggest that during brainstorming personal territories are important for reviewing and organizing ideas before communicating them and that users are willing to carry out multiple interactions (positioning and rotating of

notes) to establish them. After establishing their personal territories and presenting their ideas to each other, most of the groups begun to create a shared model based on their digital artefacts (IERs). They changed the position and orientation of their IERs and by that they dissolved their personal territories. We refer to this change from two personal territories to a shared external artifact model as territorial flow. Besides rearrangement of the digital notes, we also observed rearrangements of the participants' spatial position at the tabletop from a face-to-face to a side-to-side arrangement predominantly in the dynamic territories condition. The participants who kept their position at the table preferred a digital object orientation that allowed an equal reading perspective for both participants. It seems that depending on the spatial arrangement assumed, the participants used different strategies in their territorial flow. Based on the qualitative results presented here, we consider that better understanding the naturally occurring territorial flow might lead to new interface designs for collaborative work.

Future examinations

In this paper, we presented work in progress on the influence of different types of territories on territorial behavior and introduce the concept of territorial flow. Our observations show some evidence for the territorial flow concept introduced here and underline the role of constructing of a shared external model for the collaborative work. Further analyses of the collected data are going to include an investigation of the role of territories on group task performance and on collaborative processes.

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