The Role of Psychological Ownership and Ownership Markers in Collaborative Working Environment

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ABSTRACT

In this paper, we present a study concerning psychological ownership for digital entities in the context of collaborative working environments. In the first part of the paper we present a conceptual framework of ownership: various issues such as definition, effects, target factors and behavioral manifestation are explicated. We then focus on ownership marking, a behavioral manifestation that is closely tied to psychological ownership. We designed an experiment using DiamondTouch Table to investigate the effect of two of the most widely used ownership markers on users' attitudes and performance. Both performance and attitudinal differences were found, suggesting the significant role of ownership and ownership markers in the groupware and interactive workspaces design.

Categories and Subject Descriptors

H.5.3 **[Group and Organization Interfaces]:** *Collaborative computing.*

General Terms

Measurement, Experimentation, Human Factors.

Keywords

Digital ownership, collaborative multimodal environment, marking behavior, communicative marker, defensive marker.

1. INTRODUCTION

The psychological aspects of ownership have been explored by various disciplines, such as anthropology, psychology, philosophy, marketing, and business management [4]. Ownership has been studied within a variety of contexts, including child development [18], consumer behavior [5], and organizational behavior [28]. These works suggest that possession is a fundamental human concern. However, previous research focuses primarily on ownership of *physical* objects such as toys, houses, and stamps.

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Though the theoretical and empirical literatures suggest that humans develop feelings of ownership toward non-physical entities such as ideas, words, artistic creations [18], so far, ownership of *digital entities* (digital ownership) has not been thoroughly studied within the context of Computer Supported Cooperative Work [6] Human-Computer Interaction (HCI), or machine-supported Human-Human communication.

Ownership is not critical in single-user settings such as desktop systems. Single user desktop interfaces, especially the file management system, have mechanisms to allocate and identify ownership [33]. For example, desktop applications have platform- or application-specific defaults such as where to save a document (typically in a user's "My document" folder). Users have full authority over the modification of content on their own machines and know precisely when others are using their systems.

In contrast, technologies such as interactive spaces, multimodal interfaces and mobile computing dramatically change the way people create, share and own digital items [24]. For instance, multimodal input and output are used to create and share information and objects that are then manipulated by others [1] [37]; personal data can be acquired and made available both publicly (e.g., in shared systems) or privately [38] [39]. In all these cases, the role and impact of psychological ownership is of the utmost importance. Still, few is known about the way the interaction between the various aspects of ownership and the properties of interfaces affect users' performance and attitudes, [11] [19] [23] [33]

Prompted by these precedents, we would like to present a conceptual framework of ownership with the intention of extending it to the context of digital entities and collaborative environments and establishing some groundwork for future research. In this initial investigation, we focus on the touch input modality because it resembles the manipulation of physical objects.

In the following sections, we will first propose the conceptual framework, providing details on the key dimensions of ownership and ownership marking. We will then focus on ownership markers, one behavioral manifestation that is prominent and distinguished in collaborative workspace. We will then report an experiment designed and implemented to explore the similarities and differences between two main types of ownership marker in affecting users' perception and performance, especially for collaboration.

2. PSYCHOLOGICAL OWNERSHIP

2.1 Definition

Beggan [4] defined "psychological ownership" as the state in which individuals feel an object or a piece of one object as "theirs." Pierce et al. [28] further elaborated ownership as "the feeling of possessiveness and of being psychologically tied to an object." This definition of ownership is applicable to both physical and non-physical objects; thus, it would seem that there is no need to create a separate definition for ownership toward digital entities.

2.2 Effects

The psychological state of ownership leads to interesting consequences. For example, people treat objects they own differently than other objects [15]. There are numerous positive and constructive behaviors associated with that, which can be categorized into two key dimensions: *enhancing responsibility* and *increasing value*. Enhancing responsibility describes how ownership will promote feelings of responsibility for the target by the owner [9] [22]. This feeling leads people to be protective, nurturing and caring for the target. Increasing value refers to the perceived importance of the target object by the owner [30] [31]. Psychological ownership has negative effects, too. In many cases, ownership impedes cooperation [28]. People may become obsessed with enhancing their ownership at the cost of other people. In addition, when people witness radical alteration of targets that they perceive as being theirs, they may come to feel personal loss, frustration and stress. These effects find their origin in the lack of control over what once was theirs [2]. Since the psychological state of ownership has strong consequences and effects on people's behavior and perception, it is important for us to have a better understanding of this phenomenon within the context of collaboration systems. By studying ownership toward digital entities, we are most interested in the impact of ownership on collaboration and cooperation. Our key concerns are group performance and individual group member's attitudes, aiming, at the same time, at promoting collaborative behavior without diminishing responsibility and value.

2.3 Motives of Ownership

There are three main motives why humans develop feelings of ownership toward physical entities (see Figure 1). Behaviors related to owned objects can have a perceptive grounding: people tend to signal the ownership of an object to easily support the implicit cognitive need to tail and categorize the world in perceptive units [17]. In a world with other cognitive beings, possession is insecure; only when potential possessors have a common perception of who owns what, possessions are secure and cognitive costs decreased [25]. Ellwood [12] suggested that another key motivation of ownership might be the instrumental "use" of an object to satisfy a need or a wish. In this sense the ownership of this object is related to the efficacy and feeling of control oriented to an objective [14] [30].A third motivation of ownership behavior is investing the self in the target. The investment of the self allows individuals to see their own reflection and prolongation in the target and to feel their own effort in its existence [29]. In this sense the motivation for ownership is symbolic: through connections to objects, people can communicate their identity [10].

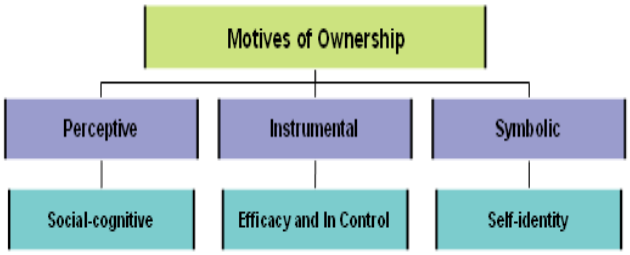

Figure 1. Three motives of psychological ownership.

2.4 Factors for Ownership

The ownership literature lists three categories of moderating factors which influence the development of psychological ownership: *individual factors, target factors* and *context factors.* Individual factors are related to differences in term of strength of motives for ownership and have been studied in gender, personality, social and economic status. Target factors can be defined as the attributes of an object that satisfy and promote the development of ownership. Finally, context factors are related to physical or environmental aspects of context, such as space, distance, barriers, that can modulate the opportunity to engage in behaviors leading to ownership. In this paper we will focus on a specific target attribute of digital entities: the presence/absence of ownership markers (see below).

3. BEHAVIORAL MANIFESTATION – MARKING BEHAVIOR

Through behavioral manifestations, owners can signify their ownership, observers can make inferences about whether the target object is owned or not. There are many behavioral manifestations that match the necessity to express self-identity, the social-cognitive need and the demand of feeling of control. Among these, we focus on *marking behaviors* and their impact on users' attitudes and behaviors.

Marking refers to those behaviors that construct or communicate to others one's ownership attachment to a particular object [6]. It requires the use of symbols and boundaries to express one's ownership. Marking can be relatively permanent, establishing enduring boundaries toward an object for an indefinite period of time. It can also be done on an ad-hoc basis, when the need is temporary [3] [32]. Various applications such as collaborative authoring, collaborative design, database creation and access, file-sharing, etc., utilize marking to signify ownership of digital content. User can easily attach markers to content they generate as well.

In multimodal contexts the marking behavior is even more important, given the increased possibility for users to create and exchange digital objects, and the possibility that personal data are acquired by the system, processed and fed back both to the user him/herself, or to other parties.

Marking behaviors are often realized through, give raise to, or triggered by target factors, that is, markers attached to objects. We distinguish two different types of markers people use to indicate their ownership: *communicative or proactive markers*, and *defensive or reactive markers*.

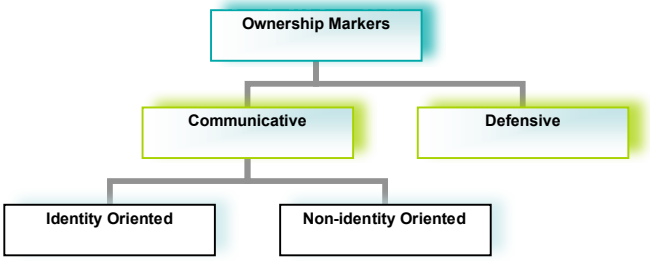

Figure 2. Variations of ownership markers

3.1 Communicative Markers

Communicative markers can be further divided into two sub-categories: *identity-oriented* and *non-identity oriented* (See Figure 2). The first form involves marking an object with symbols such as a name, picture and emblem that reflect one's identity [32]. For example, we observed that users label certain files or folders in a shared lab computer with their names to indicate their possession of those files or folders. Another example comes from collaborative authoring, in which co-authors mark the content they contribute with their names.

An interesting example that partially reflects the impact of communicative identity marking comes from a visualization plug-in for CVS, a source code version control system. With this plug-in, each programmer in a project group could pick a color or an icon to represent himself/herself in the CVS system. Afterwards, any file the programmer checks in or out carries that marker. Several groups in a large computer science class tried the tool. Over time, a trend emerged such that each programmer would not trespass on files that primarily carried another co-worker's marker. This observation resonates with what Extreme Programming claims about collective ownership [36].

All identity-oriented communicative markers communicate to others that the target object is claimed, thereby discouraging access. On the other hand, they do not prevent access or infringement.

Another form of communicative marker is not identity based, in the sense that it does not involve marking an object with one's identity. For example, a drive with a sign reading "private property", an engagement or a wedding ring on someone's left ring finger, and a conference room with a sign outside saying "taken" all mark the fact that someone owns the object, while not providing information about the specific owner. Despite the lack of specificity, non-identity markers operate in much the same way as identity markers: they communicate that a certain target is owned while not technically preventing access or use of the target object.

3.2 Defensive Markers

Unlike communicative markers, which express ownership proactively and explicitly, defensive/reactive markers function to thwart access. Locking a door, for example, is a type of defensive marker. When a user tries to execute an application or to open a file and receives a message telling he/she doesn't have permissions, that message is another example of a defensive marker.

3.3 Functional differences of the markers

Defensive markers and communicative markers are different in nature. Defensive markers establish impermeable, resilient boundaries (e.g., a lock or a fence) and stop people from being successful in their access attempts. On the other hand, communicative markers are a form of overt, visible and meaningful communication to others that the target of ownership has already been claimed while not preventing their use.

These two types of markers also vary in functions. Communicative markers function through persuading others not to attempt to gain possession of the marked object. In contrast, defensive markers react to infringement by stopping people from being successful in accessing owned objects.

Communicative markers and defensive markers can be used hand-in-hand to indicate ownership. A bright yellow bicycle lock is an example of both types of markers: the highly visible and unusual color communicates ownership, while the inability to move the bicycle is a clear defensive marker.

4. MARKING BEHAVIOR EXPERIMENT

A better understanding of the impact of ownership markers on users' behavior and attitude would help us improve the design of multimodal systems supporting collaboration. Relevant questions are the followings: does the presence of makers change the attitude of subjects towards the task and/or the partners? Given the relationship between privacy and ownership (both share specific issues about control), and the relevance of the former for ubiquitous system design [40], do ownership violations change users' attitudes? Given the importance of groupness for the success of collaborative practices and systems, do ownership markers change perceived groupness?

To address some of those issues, we designed and implemented the study described below aimed to explore the similarities and differences between communicative and defensive marker in affecting users' perception and performance in collaborative working environments. In the experiment, the participants manipulate common digital entities to achieve a common objective. An underlying system provides the relevant ownership markers. The study focuses on the effects that specific attributes of digital entities — namely, communicative and defensive ownership markers — have on people attitudes and behavior. In this work we will report only on the attitudinal results.

4.1 Experimental Task

The task involves a group of two participants solving a scrambled picture puzzle. Puzzle games are good settings for studying collaboration, as investigated in [21]. This puzzle game is implemented on a DiamondTouch Table to enable the two participants to work together (see Figure 3). The DiamondTouch (DT) Table [8] is a touch-sensitive, top-projected display. The table allows multiple users to touch the surface of the display at the same time, and to drag items across the table's expanse. Through capacitive coupling across pads participants sit on, the attached computer can tell apart the two users' touches, even when they are simultaneous.

At the beginning of the puzzle game, the following objects appear on the surface of the DT Table: 1) a target picture, which represents how the puzzle looks like once completed correctly,

located in the upper part of the table; 2) a solution area, positioned in the region of the surface proximal to participants and horizontally centered, which is the place where pieces be dragged to complete the puzzle (see Figure 4); 3) sixty-four rectangular puzzle pieces which, during the game, float slowly on the table surface. Both participants can reach any of them, this way avoiding that proximity and territoriality affect the subjects' behavior and responses.

The actions which participants can perform during the game are relatively simple. A puzzle piece can be taken, by pressing on it with a finger, and dragged to a new position. If the piece is released outside of the solution area, it will start to float around again. If it is released within the solution area, it will remain in the grid cell which is closest to the releasing position. Tapping on a resided piece will release it from the solution area.

In our study, ownership of a puzzle piece results from having used it to contribute to the solution, hence, from having dragged it into the solution area. Ownership violations, in turn, result in attempts (be they successful or not, and depending on the experimental conditions, see below) to access to puzzle pieces released in the solution area by the other user.

Since we were interested in the impact of ownership markers on users' behavior and attitudes during a common task, the marking behavior was not performed by the users but by the system: the latter marks a puzzle pieces only once it has been dragged by a participant into the solution area, that is, once it has been made his/her, according to our operational definition of ownership. This procedure secures that the marking behavior and its results (the markers) are uniform for all the users in a given experimental condition. Of course, users were informed about this feature of the system.

4.1.1 Implementation of the markers

For what concerns the *communicative marker*, we implemented it so that it could be *identity-oriented*: all puzzle pieces that a player has put into the solution area carry his/her name in the upper left corner. The name appears as soon as the piece is entered into the solution area, and disappears as soon as the piece is released.

Figure 3. Participants playing puzzle game with the Diamond Touch Table

Since defensive markers are meant to establish boundaries and stop/prevent other people from successfully accessing to one's resources, the defensive marker consisted in a restriction of the use of puzzle pieces once they were inserted in the solution area. The player who put a piece into the solution area could remove it freely while the other player could not. Failed attempts at moving a puzzle piece belonging to the other player were indicated both visually (a "stop" sign) and acoustically (a sound like the usual Microsoft Windows critical error).

4.2 Experimental Design

This study was conducted using a between-participants design and consisted of four experimental conditions. As illustrated in Table 1, communicative and defensive markers are treated as the two independent variables (factors), each with two different levels: presence vs. absence of the marker. In the first experimental condition, no markers for ownership were employed (control condition); in condition two, only the communicative marker was present; in condition three only the defensive marker was applied, and in condition four, both the markers were used.

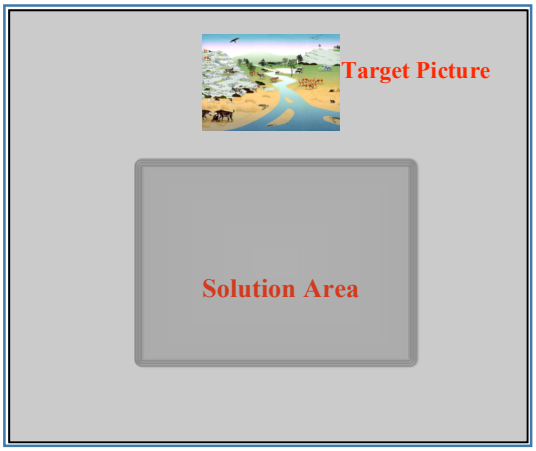

Figure 4. Puzzle game interface

Table 1. Experimental Design

		Communicative Marker	
		Absent	Present
Defensive Marker	Absent	Control Condition	Communicative marker only
	Present	Defensive marker only	Both markers

4.2.1 Participants

One hundred and eight undergraduate students, 54 male and 54 female (mean age = 22.8, st.dev = 4.76) volunteered as participants. The study was conducted on two sites: in the University of Trento, Italy, and in the Stanford University, USA. We arranged our participants into different groups according to two criteria: first, they were of the same gender; second, participants in the same group were not acquaintances before the study.

4.2.2 Procedure

Participants entered the room and were introduced to each other. Then they were invited to sit at the DiamondTouch (DT) table side by side (see Figure 3). After hearing an overview of the

study, with explanations concerning the system behavior, participants were given two questionnaires to fill out. The first questionnaire was a Locus of Control scale [7][13], while the second was an Extraversion scale extracted from the Big Five Questionnaire [26] [34]. Once the participants completed the questionnaires, the experimenter gave them a paper containing the instruction and the rules of the puzzle game. Instructions were identical for all experimental conditions, except for one paragraph that explained the differences between markers, and the system's behavior in this connection.

Before starting the task, participants underwent a training session that consisted of completing a similar, but much simpler version of the puzzle. The purpose of the training session was to let participants get familiar with the task and with the markers (if any were present). During the training session, the experimenter helped the participants to complete the puzzle by showing them how to enter pieces in the solution area and how to remove them. In conditions involving defensive markers, the experimenter invited participants to try to remove a piece from the solution area that had been placed there by the other participant. In the conditions involving communicative markers, the experimenter introduced the presence of the participants' names on the pieces they inserted in the solution area.

After the training session, the experimenter started the real experimental task. No time limits were imposed for task completion. Upon completing the puzzle, the system would notify participants that they achieved the correct solution. Then participants had a brief break before being given a third paper-and-pencil questionnaire to assess their attitudes toward the task and the other participant. A debriefing session followed the completion of the questionnaire, at the end of which participants were thanked and escorted out of the room.

4.3 Measures

4.3.1 Attitudinal Measures

In this paper we mainly consider attitudinal measures to investigate how they are affected by the communicative and defensive marker. The attitudinal dimensions addressed by the questionnaire can be grouped into the following four categories.

4.3.1.1 Attitude Towards the Task

Beggan [4] found that ownership affects the satisfaction and pleasure in executing a task. This dimension was addressed in our questionnaire by asking questions beginning "How well do the following words describe how you felt when completing the task?", followed by a list of adjectives. The response scales were anchored by "Describe Very Poorly" (=1) and "Describe Very Well" (=10). Twenty items were used. At the end of the experiment, the responses underwent a factor analysis (PCA + Varimax rotation) and a reliability analysis (Crombach's alpha), discarding items to achieve an alpha of at least .5. This procedure allowed us to single out three latent variables underlying subjects' attitudes towards the task. Table 2 reports them along with the composing items and the value of Crombach's alpha.

4.3.1.2 Attitudes Towards the Other Participant

Subjects were asked to describe the other participant through a list of adjectives. The same factorial analytic procedure as in section 4.3.1.1 was used here. The results are reported in Table 2.

4.3.1.3 Attitudes Towards Ownership Violation

Bartunek [2] found that the loss of control on owned objects leads to a sense of frustration and personal loss. We addressed the consequence of ownership violation both when it was suffered by the participant and when it was performed by him/herself. As with the attitudes towards the puzzle and towards the other participant, the subject had to describe how he/she felt like by means of a list of adjectives. The results underwent the same factor analytic procedure described above; see Table 2. for the final dimension and their item composition.

Table 2. Attitudinal Measures

Dimensions	Latent Variables	Items	Cronbach's Alpha
ATTITUDES TOWARDS THE PUZZLE TASK	Involvement	Enjoyed Entertained Having fun Interested	0.89
	Discomfort	Frustrated Inhibited Stressed	0.65
	Skill	Competent Intelligent	0.66
PERCEPTION OF THE OTHER PARTICIPANT	Skill	Competent Cooperative Efficient Intelligent	0.81
	Discomfort	Frustrated Opponent Stressed	0.78
	Activation	Passive (R) Productive	0.74
SUFFERING OWNERSHIP VIOLATION	Discomfort	Annoyed Frustrated Offended Tense	0.82
	Collaboration	Cooperative Supported	0.91
VIOLATING THE OTHER'S OWNERSHIP	Challenge	Aggressive Challenging Competitive Conquering Intrusive	0.73
	Guilt	Guilty Tense Tentative Unaware	0.64
	Collaboration	Cooperative Supportive	0.70

4.3.1.4 Perceived Performance

According to Hammer [16], ownership is a motivation factor for task execution. In our questionnaire, the subjective perception of performance for the puzzle game was investigated by asking participants "how quickly do you feel that the two of you solved the puzzle". They rated their performance from "Much slower than average" (=1) to "Much faster than average" (=10).

4.3.1.5 Feeling as a Group

We were interested in understanding if and to what extent the different ownership markers affected the perception of groupness by our participants. We therefore asked our subjects to indicate to what extent they felt that they and the other participant belong to a group after the puzzle game.

4.3.2 Personality Measures

Individual factors are among the moderating factors of psychological ownership, and personality is one of them. For example, Beggan [4] showed that ownership is affected by the individual factor known as Locus of Control (LoC) and Prentice [27] demonstrated that the extent to which people utilize their possessions to satisfy control motivations varies across individuals. Winter et al. [35] found that the extraversion trait influences people's strategies to obtain pursued targets: for example extraverts may prefer to pursue targets through social interactions instead of by monopolizing objects.

Although it was not a goal of ours to investigate the effect of personality traits on people's reactions to ownership markers, we included in our study measures for LoC and extraversion to use as covariates in our analysis, this way controlling for their effects.

LoC was measured by means of the Italian and English versions of Craig's LOC scale of Behavior [7] [13]. For extraversion, we used the extraversion sub-scale of the Big Five Marker Scale, an adjectival version of the BFQ [20] [26] [34] translating the Italian version in English for its use at the Stanford test site..

4.4 Results

4.4.1 Attitudinal Dimensions

The results reported in the next four sections refer to a series of MANCOVAs (Multivariate Analysis of Covariance) ran on the data from the attitudinal measures described in sections 4.3.1. The between factors were Com and Def, and the covariates were the LoC and Extraversion. MANCOVAs for the multifactorial dimensions discussed in section 4.3.1 — namely, attitude towards the task, towards the other, and feelings due to own and the other's ownership violation —used the factorial scores for the latent variables computed through standard procedures.

For the sake of readability, all the results discussed henceforth refer to standardized scores (T-scores: mean=50, SD=10) for all the measures. We will only discuss statistically significant effects, using COM, NO-COM, DEF and NO-DEF with the obvious meanings to indicate the values of the two factors; M_0 and M_1 will indicate the mean values of a variable when the relevant factor has level 0 (absent) and 1 (present), respectively.

4.4.1.1 Attitudes Towards the Task

We found a main effect of Com for the attitude towards the puzzle dimension (Willk's lambda=0.858, $F_{3,100}$=5.518, p<.01, η^2=.142, observed power=.933). According to the univariate test, this was due to a main effect of Com on both Involvement (F_1=4.854, p<.05) and Discomfort (F_1=10.895, p<.001). The outcome is that subjects felt both less involved (M_0=52,4, SE=1,5; M_1=47.9, SE=1.3) and more uncomfortable (M_0=47.2, SE=1.3; M_1=53.5, SE=1.4) when the communicative marker was present.

4.4.1.2 Evaluation of the other participant

The defensive marker has a significant main effect on how participants evaluated their co-players (Willk's lambda=.882, $F_{3,100}$=4.442, p<.01, η^2=.118, observed power=.865). This multivariate effect was due to an effect of Def on Discomfort (F_1=12.994, p<.001) according to which the other was perceived as more discomforted in the presence of the Defensive marker than in its absence (M_0=47, SE=1.3; M_1=53.6, SE=1.3)

4.4.1.3 Violated by the Other Player

Com has a main effect on the feelings due to the other participant's violations (Willk's lambda=.892, $F_{2,100}$=6.036, p<.01, η^2=.108, observed power=.875). The univariate test traced it back to an effect of Com on the Discomfort dimension (F_1=11.601, p<.001) in such a way that people felt more uncomfortable when ownership violation happened with the presence of Com than with its absence (M_0=46.4, SE=1.4; M_1=53, SE=1.3).

4.4.1.4 Violating the Other Participant's Ownership

The feelings of violating the other participant's ownership were affected by both Com (Willk's lambda=.890, $F_{3,99}$=4.063, p<.009, η^2=.110, observed power=.830) and Def (Willk's lambda=.902, $F_{3,99}$=3.577, p<.05, η^2=.098, observed power=.775). At the univariate test, Com was shown to affect Challenge factor (F_1=9.848, p<.01) with people perceiving themselves as more challenging in COM than in No-COM (M_0=46.8, SE=1.4; M_1=52.7, SE=1.3).

Def affected both Challenge (F_1=4.86, p<.05) and Collaboration (F_1=6.451, p<.05). In both cases the presence of the marker lead to an increase of the values on the relevant dimension; that is, people felt both more challenging (M_0=47.8, SE=1.3; M_1=51.7, SE=1.3) and more collaborative (M_0=47.6, SE=1.4; M_1=52.4, SE=1.3).

4.4.1.5 Performance

Univariate ANOVA of completion times with communicative marker and defensive marker as between-participants factors showed that both markers slowed down participants significantly (Com: $F_{1,50}$=4.064, p<.05; Def: $F_{1,50}$=4.495, p<.05). As shown in Table 3, participants completed the puzzle game faster without any markers.

Table 3. Task completion time

Time (mins) (SD)	**Com = absent**	**Com = present**
Def = absent	11.75 (1.96)	14.79 (4.32)
Def = present	14.92 (6.34)	17.20 (5.32)

The subjective perception of the performance (perceived time to completion) was affected only by Com ($F_{1,104}$=5.4, p<.05). Participants believed that they finished the task faster with comm marker than without (M_0=52.42, SD=10.89; M_1=47.91, SD=8.73).

4.4.1.6 Feeling as a Group

Com had a significant main effect ($F_{1,104}$=4.41, p<.05) on participants' perception of working as a group with the other player: in COM conditions, they felt less as a group than in NO-COM conditions (M_0=52.49, SD=10.89; M_1=47.86, SD=9.78).

4.4.2 Covariates effects

No significant effects of the covariates on any group of dependent variables were found.

5. DISCUSSION

This study was conducted with different types of ownership markers, namely, *communicative* and *defensive*, trying to investigate their impact on user's attitudes. Table 4 summarizes the results of this study.

Table 4. Summary of the effects of markers (+ = increase, - = decrease)

Dimensions	Variables	Com	Def
Attitude towards the Task	Involvement	-	
	Discomfort	+	
Perception of the other participant	Discomfort		+
Suffering ownership violation	Discomfort	+	
Violating the other's ownership	Challenge	+	+
	Collaboration		+
Groupness		-	

Globally, we have shown that ownership markers affect users' attitudes and experience in cooperative tasks; in all the cases we considered, they act independently one from the other, with the communicative one seemingly being more effective. Both markers slowed down significantly the completion time of the task.

Communicative marker made participants feel less involved in the task, and more uncomfortable. A similar effect can be found when users encountered a violation of ownership by the other participant; this result is consistent with the ownership literature (see par. 2.2) which reports that when people witness radical alteration of targets that they perceive as being theirs, they may come to feel personal loss, frustration and stress [2]. Even perceived groupness diminishes with the communicative marker, a result that could be related to the fact that the identity-oriented markers we used to induce people to care more about their own contributions at the expense of groupness. At the same time, the presence of the communicative marker produced a clear increase of the perceptions related to an aggressive and conquering behavior when taking pieces owned by the other. Finally, the communicative marker decreased the subjective perception of the task completion time; this result, though somehow contrasting with the perceived decrease of involvement in the task, can possibly be explained by the fact that having a common perception of who owns what reduces cognitive costs [25], which might explain the shorter perceived completion time.

The presence of the defensive marker yielded three main effects. First, it increased the perception of the other participant as being uncomfortable, that is, more frustrated, opponent, and stressed. Secondly, similar to the communicative marker, defensive marker increased the feelings related to an aggressive and conquering behavior when violating other's ownership. In the same situation, it also increased the feeling of being cooperative and supportive. These effects, if confirmed by further studies, and together with the absence of a significative sense of frustration and discomfort when suffering ownership violation, may suggest that the defensive marker is more perceived as a constraint which helps structure own work than as a limitation that tampers collaboration.

6. CONCLUSIONS

The possession of objects has been one of mankind's most puzzling behaviors. Various previous works suggest that the psychology of ownership is well-rooted in humans. We are interested in extending the previous research about psychological ownership to collaborative multimodal environment. In this paper, we have a) proposed a conceptual framework and b) some preliminary finding from a study designed and implemented in accordance with the framework, to explore marking behavior within the context of interactive group workspaces. We hope that more researches on psychological ownership will arise and more interesting findings will emerge. As to ourselves, future efforts will be directed towards the analysis of behavioral data gathered during the experiment described in this paper; the purpose is to shed light on the way ownership markers affect behavior and interaction patterns and connect these further findings with those described here in a more comprehensive theory of ownership in multimodal context.

7. REFERENCES

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