Understanding the Implications of *Social Translucence* for Systems Supporting Communication at Work

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ABSTRACT
In this paper we describe a study that explored the implications of the *Social Translucence* framework for designing systems that support communications at work. Two systems designed for communicating availability status were empirically evaluated to understand what constitutes a successful way to achieve *Visibility* of people's communicative state. Some aspects of the *Social Translucence* constructs: *Visibility*, *Awareness* and *Accountability* were further operationalized into a questionnaire and tested relationships between these constructs through path modeling techniques. We found that to improve *Visibility* systems should support people in presenting their status in a contextualized yet abstract manner. *Visibility* was also found to have an impact on *Awareness* and *Accountability* but no significant relationship was seen between *Awareness* and *Accountability*. We argue that to design *socially translucent* systems it is insufficient to visualize people's availability status. It is also necessary to introduce mechanisms stimulating mutual *Awareness* that allow for maintaining shared, reciprocical knowledge about communicators' availability state, which then can encourage them to act in a socially responsible way.

Author Keywords
Social Translucence, Visibility, Awareness, Accountability, mediated communication, socially responsible behaviour, ambiguity

ACM Classification Keywords
H.5.3 Group and Organization Interfaces, H.5.2 User Interfaces

INTRODUCTION
Social Translucence is a concept defined by Erickson and Kellogg [12] as a way to approach "*designing systems to support communication and collaboration among large groups of people over computer networks*". It incorporates different properties of Face-to-Face communication, namely: *Visibility*, *Awareness* and *Accountability* into any mediated setting. *Visibility* defines the degree to which socially significant information is made visible in the system. This construct consists of two components: the extent to which provided information is likely to be perceived as significant by all system users and also how well that information is represented by the system. *Awareness* reflects the extent, to which all systems users know what information is being shared among them and also what others can see about their behaviour. Finally, *Accountability* can be seen as basis for creation of social norms as a consequence of a mutually understood possibility of being held responsible for one's actions. Emphasizing these three properties of Face-to-Face communication in any mediated setting is likely to support people in structuring their communications in a socially responsible manner.

Prior studies reported that, in mediated communication, availability status that imprecisely conveys an intended communicative state may wrongly suggest 'always-on' availability and rise false expectations regarding the ways communication should unfold [6, 7, 11, 14, 19]. Several solutions were proposed to deal with that problem [4, 5, 8, 11, 27, 29, 30], many of which seek to become *socially translucent* [6, 14]. These solutions typically aimed at supporting *Visibility*, i.e. by automatically collecting and displaying socially significant information about people's communicative state. However, a number of studies reported that such systems seemed not to be able to invoke *Awareness* and *Accountability*, i.e. users reported that their colleagues would not respect their status representations and that they did not feel entitled to hold them accountable for not respecting that status [7, 13].

In this study we set out to investigate whether the reason that automatic systems were unsuccessful in becoming *socially translucent* was because they failed to attain a

sufficient level of *Visibility* of people's communicative state or was it due to the fact that even if a satisfactory level of *Visibility* was achieved in a system it did not necessarily guarantee obtaining sufficient *Awareness* and *Accountability.*

RELATED WORK

Many systems provide information regarding people's communicative state by automatically inferring their availability status based on video-streaming [31], through the analysis of the content of agendas or daily rhythms [7], or by logging computer activities and various sensory data captured from people's environments [6, 13]. Those solutions, however, are not very successful in acting as *socially translucent* systems. It was found that co-workers did not always respect their colleagues' availability status and participants were not able to establish ways allowing them to demand respect of that status. Based on the analysis of different characteristics of some systems [7, 13, 30, 32] we could identify three possible explanations why an automatic availability indication might insufficiently support attaining satisfactory level of *Visibility* and therefore cause those systems to fail to become *socially translucent*:

An automatically detected availability status seems insufficiently reliable to potential communicators. Romero et al. [28] have shown that the decision to become available for communication depends on people's moment to moment activities and easily changes depending on e.g. social proximity between communicators. Many automatic systems try to assess people's communicative state by analyzing the content of their agendas and daily rhythms [7], or by looking into their activities using sensors [6, 13]. Based on that data they attempt to create computational models determining the degree to which a person is available for communication. However, those models need considerable time to register a transition from one contextual state to another and update the status accordingly [7]. Furthermore, substantial time is needed to construct a model that effectively predicts one's communicative behaviour. Finally, they are not very successful in interpreting the impact of social relationships between people on their communicative behaviour [4]. Due to these reasons potential communicators are likely to treat the availability indication inferred by the system as insufficiently reliable in presenting the communicative state of their colleagues. Therefore, it is necessary to assess what availability indication would be perceived by people as believable and would motivate them to comply with the status represented in the system.

An availability indication provided by an automatic system remains too generic or is displaying context that is insufficiently informative. Systems using computational models to assess people's communicative state tend to generalize that state into three levels indicating that someone is either available, moderately unavailable or highly unavailable [13, 31]. Such generic information about people's availability status may be perceived as insufficiently informative to allow for an assessment regarding which moments are appropriate for initiating communication and which are not.

Other systems, besides providing generic status indication, offer a video channel as an additional source of information regarding people's communicative state [27, 30]. However, a video channel seems to only partially succeed to inform people about the state or activities of their colleagues. Seeing on a video that someone is sitting in front of the computer and looking at the screen may either mean that that person is concentrated working on an important report or maybe just reading news on the Internet. It seems that providing a video channel is still insufficient to support effective assessment of whether one should initiate communication or not. Therefore, to become sufficiently informative, availability indication should consist of information that allows co-workers to effectively assess what are the appropriate moments to initiate communication with their colleagues.

An automatic system does not provide space for ambiguity regarding people's communicative state. In order to attain satisfactory *Visibility* of their availability status people need to be able to display a status that represents their psychological rather than perceptible state (and these two might be very different). An automatic system detects and displays perceptible rather than intended information, and therefore it is likely to be perceived as a threat to people's privacy [7] because e.g., by displaying certain information it might negatively affect their "professional face" [18]. Furthermore, people seem to feel threatened by the fact that they have no control over what information is being presented by the system and therefore they have no control over the image they are projecting to others [9]. Therefore, in order to overcome the possible privacy threats it is necessary to provide people with ways to control information that is presented in the system and also allow them to adapt it whenever necessary.

Manual status representation

An alternative to systems automatically inferring their availability status can lay in providing people with a lightweight manual way to determine their communicative state. A proposal of a manual availability indication is not new. Buxton argues that elements embedded in people's environments that are manually operated (e.g. doors) can be used to determine the virtual representation of one's communicative state and at the same time allow people to control that representation through a physical interaction with that particular object [10]. Milewski and Smith [23] showed that people are inherently motivated to update their status especially if they can see a potential benefit for their actions and at the same time the effort to do so is not extensive. A system supporting manual availability indication offers advantages missing in automatic systems.

It allows for adapting the representation of one's communicative state at any moment in time, also at moments that may be perceived by any automatic system as the same activity or state. Such a solution is also likely to offer a possibility to keep the overall status unchanged even though observable activities might change, e.g. when a person is writing a report, he/she might be reading relevant material, searching on the Internet for additional information and writing the text. Those are different activities but the overall status might indicate that one is very concentrated and available only for urgent matters. Furthermore, manual availability indication gives people the possibility to define their status for both short and long period of time (like hours or even an entire day) although the main risk is that people may easily forget to update that status when their situation changes [23]. It also provides room for ambiguity [3, 8] by allowing people to decide in what way their communicative state should be reflected in the system so that they can protect their solitude and self-image at all times regardless of their present situation or activity [18, 25].

Exemplary mechanisms for manual adaptations of the automatic representation of one's communicative state were implemented in the Community Bar system [22] and are based on *Focus* and *Nimbus* model by Rodden [26]. *Focus* is a mechanism that enables people to direct their attention towards some colleagues but not to others, while *Nimbus* allows them to control how much of the 'self' they broadcast [27]. *Blurring* is another mechanism that allows people to control the granularity of information they display to others by allowing them to distort their video image [9]. Those mechanisms are successful in supporting ambiguity but they still seem to fail to be sufficiently informative about people's communicative state. Therefore, our first objective in this study was to further explore the design space for systems supporting manual availability indication and try to answer the following question:

***Q1**: What is a successful way to achieve* **Visibility** *of one's communicative state in systems supporting mediated communication?*

As previously mentioned one reason why systems that automatically infer people's availability status are not succeeding to become *socially translucent* might occur due to the fact that they insufficiently support *Visibility* of people's communicative state. Another reason might be that even if sufficient level of *Visibility* is achieved such systems fail to support mutual, reciprocical *Awareness*. We argue that current systems seem to only support what can be called '*one-way Awareness*' meaning that only a communication Initiator knows whether (s)he viewed and conformed to the availability information that is presented in the system. As there is no mutual *Awareness* achieved, there is no basis for stimulating *Accountability*. Therefore, our second objective is to answer the following question:

Q2**: What other mechanisms are needed in order for a system to become* **socially translucent?*

By answering these questions we hope to derive design guidelines allowing to attain sufficient level of *Visibility* of people's communicative state and provide insights into how systems supporting mediated communication should be designed so that they can become *socially translucent*.

DESIGN

Earlier we discussed various reasons why automatic systems may fail to invoke sufficient *Visibility*, namely due to: inadequate reliability, informativness and ambiguity. In order to define our design space we have reformulated those aspects into the following design principles:

- The system needs to be informative about people's communicative state thus it should provide co-workers with a comprehensive explanation about moments, in which communications are likely to have a disruptive effect on people's performance and emotional state. Those include moments of high concentration and increased time-pressure due to incoming internal or external deadlines. Increased annoyance can also be caused when a person is exposed to multiple interruptions in a short period of time [2, 5, 20, 26].
- The system needs to support ambiguity thus should provide space for opening and closing one's communicative borders regardless of the state of activity one is involved in and at the same time it should protect one's privacy [3, 8, 25].
- The system needs to be seen as reliable thus should provide status information that appears believable and motivates people to comply with that status.

We tried to address these principles in the design of two solutions allowing for manual status indication. In AvBox (see: *Fig. 2*) availability information took form of an abstract graphical representation of the availability, concentration, time-pressure and disturbance levels. Different levels were visualized on a 7-point scale on which: level 1 (marked on the device with a green line) indicates high availability and low concentration, time-pressure and disturbance level, and level 7 (marked on the device as a red line) indicated high unavailability, concentration, time-pressure and disturbance levels. In StatusME (see: *Fig. 3*) availability information was presented as a short textual message chosen by the user to best describe his/her availability. Our goal was to see which of these two solutions would be perceived as the best representation of one's communicative state: the one representing the availability information in an abstract yet predefined way or the one offering the possibility to describe person's communicative state in an open, direct manner.

AvBox (see *Fig. 2*) was built with Phidgets [1]. Four Phidget Sliders and three leds were connected to a Phidget Interface Kit 8/8/8 and communicated with the PC over

USB. The status was indicated by setting the sliders according to the 7-point scale graphically represented on the device. This 7-point scale was mapped onto the 1000-scale of the Phidget Sliders and communicated to a Java program on the PC, which published the value on a central server over TCP sockets.

Participants could indicate their availability status by adjusting the first slider (ranging from available to highly unavailable) and were also able to provide additional explanation to that status by indicating their concentration, time-pressure and disturbance levels. AvBox was further equipped with three LED-lights used to indicate time since the last update (the first light would get lit after one hour, the second after two hours and third after three hours have passed since the last update). In this way we wanted to ensure unobtrusive yet communicative feedback for the AvBox user stimulating frequent use of the tool.

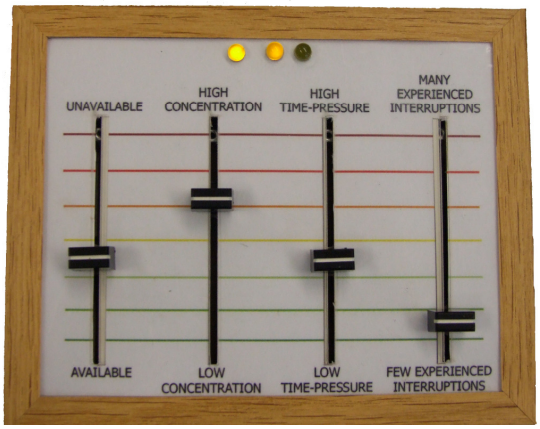

Figure 2: AvBox.

StatusME (see: *Fig. 3*) was an application running on the PC and highly resembling functionality offered by various Instant Messaging applications and identical to that existing in Twitter, a service supporting social networking through the broadcast of short textual messages describing people's present status or activity [33]. To indicate their status participants needed to type in the relevant text. The message could be changed at any time by clicking on the text box and entering a new message. The status could also be cleared using the "Clear" button, so that no message was broadcasted. The StatusME application remained semi-transparent and always on the top of other documents or applications opened on the screen as an unobtrusive reminder to update it whenever necessary. It was implemented in Tcl/TK and communicated with the central server over TCP sockets.

Figure 3: StatusME.

All statuses entered into AvBox and StatusME could be viewed through a Status Viewer (see: *Fig. 4*) — a Web-based Flash application that retrieved the status of all currently connected participants from the central server and displayed it in the browser. AvBox and StatusME pushed any change to the server that was implemented in Tcl/TK and resided on a server on the local network. The server subsequently pushed the changes to the Status Viewer in real time. It would initially display buttons with participants' names and the time of the last update. Once a button was pressed, a graphical representation of the positions of the AvBox sliders (mapping the 1000 scale of the sliders back to the 7-point scale) and/or the textual entry from the StatusME would appear. The status indication would remain visible until the button was pressed again, allowing to simultaneously view status indications of multiple persons.

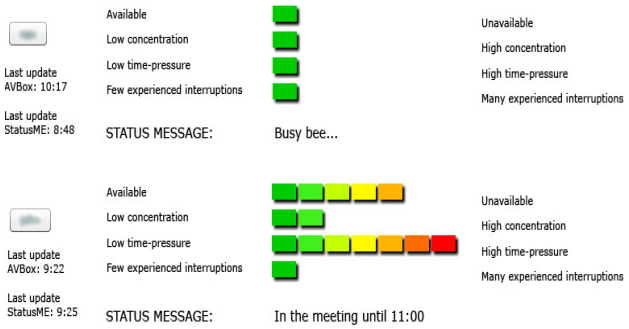

Figure 4: The Status Viewer displaying exemplary statuses of two study participants.

METHOD

Ten employees of one university department (7 male, 3 female) of whom 4 were frequent users of an Instant Messaging application agreed to participate in the study. The group consisted of 2 professors, 4 researchers, 2 employees of the financial department and 2 administrative assistants. In order to counterbalance for their professions, participants were divided into two groups, so that 1 professor, 2 researchers, 1 employee of the financial department and 1 administrative assistant formed each group (the choice per group per profession was also counterbalanced).

The study spanned a period of three weeks. During the first week one group was asked to use AvBox and the other group to use StatusME. In the second week both groups used the other system so that during those two weeks all participants were able to experience both systems, find ways to express their availability status through them and formulate their preferences. In the final week they were asked to use either their preferred tool or both tools at the same time. The goal was to see whether participants would display a clear preference for one of the proposed solutions.

In order to attain adequate attention to the study at the participants' department an email was sent to all employees

with an explanation of the study goals and the address (URL) of the Status Viewer. Next, participants were asked to forward that email to their students and colleagues. Finally, we located two computers displaying the Viewer on the department corridors nearby participants' offices (see: *Fig. 5A*), and placed study posters on participants' office doors (see: *Fig. 5B*).

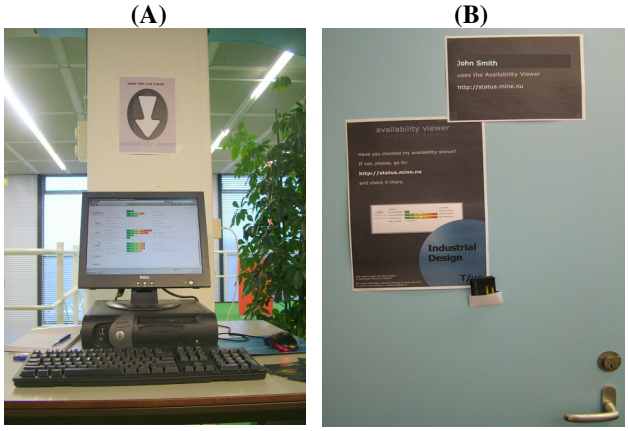

Figure 5: (A) - one of the two computers displaying Status Viewer that was located on the department corridors nearby participants' offices and (B) - a door of a participant with a study poster on it.

Data collection

In this study we aimed to collect data allowing us to: (i) analyze participants' interactions with the two proposed solutions, (ii) elicit their preferences regarding ways, in which *Social Translucence* could be achieved in systems supporting communication at work and (iii) examine their perceptions regarding causal relationships between *Visibility*, *Awareness* and *Accountability*.

All interactions with AvBox and StatusME were logged during the three study weeks. We have recorded to following data: interaction date, time and type (AvBox or StatusME). For each interaction we noted user ID and status ID (the text of each message entered through StatusME and the value of each Phidget Slider updated on AvBox).

The study was followed by 5 *Co-discovery* sessions [24] using the *Repertory Grid Technique (RGT)* [15] as data elicitation method. We have chosen for *Co-discovery* rather than individual interviews since we expected that participants would be able to better reflect on their tacit knowledge by contrasting their experiences regarding the systems with those of the peer-participant. For the subjective data collection through interviews and questionnaires we chose to compare the two proposed systems and use *Outlook Calendar* as a reference to see what characteristics of an automatic system could have a positive impact on increasing *Visibility* regarding one's communicative state. Although Outlook Calendar is not a *socially translucent* system, it reflects certain properties of other automatic systems: it attempts to model people's availability status by reflecting the content of their agendas and it does so by showing generic rather than contextualized availability status.

The systems were grouped in 3 triads (Outlook Calendar and AvBox vs. StatusME, AvBox and StatusME vs. Outlook Calendar, and Outlook Calendar and StatusME vs. AvBox). The order of the triads was randomized. For each triad participants were asked to describe *'a quality that makes two systems alike and discriminates them from the third'*. After coming up with a quality term, they were asked to describe the opposite pole, thus elicit a bipolar quality dimension that was used by them in differentiating among the three systems. Finally, participants were requested to judge '*which of the two qualities they consider to be a positive and which a negative characteristic of a system supporting communication at work*'.

As a last step, participants were asked to rate the three systems (AvBox, StatusME and Outlook Calendar) with respect to how successful they were in becoming *socially translucent*. Since no prior work has operationalized the concept of *Social Translucence* into a questionnaire, we formulated a set of questions that attempted to capture some of the preconditions for *Social Translucence,* namely that valid social cues are being produced in the system. The questionnaire did not aim to take up the issue of reciprocity in *Awareness*, neither it managed to address *Accountability* as a process of social norms creation. It only looked at how well people felt they controlled their availability information and whether they thought that sufficient information is being provided to others so that they should be able to appropriately act on it. An initial set of 21 questions (7 questions per construct) was formed. All questions were discussed and reformulated together with another researcher, whose expertise lies in the topic of awareness systems supporting mediated communication. Those questions were then again discussed in one Focus Group session with four other researchers. The resulting questions were employed in the questionnaire using 5-point Likert scale ranging from 'strongly disagree' to 'strongly agree'. Next, a confirmatory factor analysis was conducted to verify the convergent validity of the questions. The three (out of the seven) questions with the highest loadings on each respective construct were assumed to best measure the underlying construct and were used for further analysis.

Visibility was evaluated with the following questions:

Q1: I find it easy to express my availability status well.

Q2: The status I am broadcasting is well representing my availability.

Q3: My status is presented in a clear and understandable way.

'One – way Awareness' was assessed with the following questions:

Q4: I feel that I control the availability information I am broadcasting to others.

Q5: I provide rich enough information for others to understand my availability status well.

Q6: I feel that people are well informed about my availability status.

Accountability was measured with the following questions:

Q7: I request from people to check my status.

Q8: I can see that others feel obligated to check my status.

Q9: I can see that others are obligated to comply with my status.

Convergent and discriminant validity of all constructs was assessed using the Partial-Least Squares tool [16]. Convergent and discriminant validity is shown when individual scales of an assumed theoretical construct (e.g. *Visibility*) load highly on that latent construct and also display low correlation to other constructs. Both convergent and discriminant validity of the *Social Translucence* model was judged satisfactory (Cronbach's α: Visibility = .850, Awareness = .826, Accountability = .729).

RESULTS

In this section we describe the results from our three data sources. The quantitative and qualitative data gathered from the AvBox and StatusME logger demonstrates participants' behavioural patterns and preferences about the presentation of their status information. The analysis of the statements obtained during the interviews provides insights into the desired behaviour of systems supporting mediated communication. Finally, the outcome of the questionnaires suggests possible relationships between *Visibility*, *Awareness* and *Accountability*.

Logs

731 interactions were logged during the study: 485 interactions using AvBox and 246 using StatusME. AvBox was more frequently used (n.s.) during the first and the second study week (see: *Tab. 1*). A significant difference was noted with respect to the use of both systems in the third week ($t(9) = 4.42$, $p<.005$) and also significant difference regarding use of both systems throughout the entire study ($t(9) = 3.38$, $p<.01$). In that last study week, 2 participants chose to present their status using only AvBox and 8 participants used both AvBox and StatusMe to describe their availability. No participant selected StatusMe alone to express his/her communicative state. There was no order effect detected between the two groups.

	AvBox (Mean)	StatusME (Mean)
Week 1	3.76	2.26
Week 2	2.75	1.48
Week 3	5.58	2.81
Overall	4.03	2.18

Table 1: Mean values representing number of interactions on AvBox and StatusME during each study week.

AvBox

The first step in the analysis of participants' interactions with AvBox was to convert the recorded Phidget Sliders values back into the 7-point scale graphically represented on the device. Then all interactions were divided into events. An event was considered as singular whenever the consecutive event of the same user was detected 5 minutes apart from the previous one. Any activity that was conducted within 5 minutes was treated as one event. Then, for each participant, all successive representations of their availability statuses were reconstructed so we could analyze their status representations rather than only look at transitions from one state to another.

From the analysis of the status representations we saw that only in 5 cases the availability slider alone was used to represent participants' communicative state. In the remaining 480 cases at least two sliders were used to represent their status. The analysis of the consecutive adaptations of status representations showed no significant difference regarding the use of either four, three, two or one slider to describe participants' status. In 202 cases four sliders have been simultaneously adapted to express their availability, in 71 cases three sliders were used, in 53 cases 2 sliders and in 159 cases one slider was adapted (in 107 times it was the availability slider). Finally, we saw no significant difference regarding the frequency of use of the sliders: the availability slider was used 387 times, the concentration slider 307 times, the time-pressure slider 286 times and the disturbance slider was used 299 times.

StatusME

All StatusME messages were analyzed using *conventional qualitative content analysis* [21]. First, they were inspected by the first author and those considered similar were clustered together in three groups. Next, for each cluster the unique characteristics of the messages were described as follows:

- *Availability Messages* — status messages explicitly stating one's availability status without providing any context (e.g.: 'available', 'busy' or 'do not disturb').
- *Contextualized Availability Messages* — status messages explicitly stating the availability status and providing a contextual explanation for that status (e.g.: 'out of office for the next hour: doing sports', 'going home in 15 minutes').
- *Contextual Messages* — status messages stating the context to one's situation without explicitly indicating the availability status associated with that context (e.g. 'doing assessments' or 'working on the report').

All messages were again coded by the first author and one independent coder (Fleiss K = .92 [29]). The conflicting messages were discussed and assigned to the relevant category. Finally, all messages were once more coded according to whether they stated an availability or unavailability status. We could code messages explicitly stating participants' availability status (see: *Tab 2*). Such an

analysis was not possible with respect to *Contextual Messages* as those messages were not meant to straightforwardly indicate if someone was available or not.

We observed that Availability Messages were mainly used to state participants' availability for communication, while Contextualized Availability Messages were more frequently used to determine participants' unavailability. In many cases, however, participants decided to enter Contextual Messages as descriptors of their communicative state. Those messages required an understanding of their working situation in order to be effectively interpreted by others.

Status message	Total	Stating availability	Stating unavailability
Availability Messages	58	46	12
Contextualized Availability Messages	80	13	67
Contextual Messages	108	n.a.	n.a.
Total	246		

Table 2: Three types of StatusME messages and counts showing, which of them indicate availability and which unavailability status.

Co-discovery interviews

Direct qualitative content analysis was used to examine 88 statements collected during 5 Co-discovery interviews [21]. Firstly, all paired comparisons were coded according to the predefined categories (*Visibility*, *Awareness* and *Accountability*) by two external coders in two iterations. They firstly coded the statements independently (Fleiss K=.76 [29]). Then, in a joined session, they discussed the conflicting statements and assigned them to the category they both agreed upon (Fleiss K=.88). Statements (10) that remained arguable were removed from the dataset.

Visibility

Participants saw a possibility to manually set their availability status as enabling them to control the 'professional image' they displayed to their colleagues. They liked the contextualized way AvBox offered to explain their communicative state; they thought that the three descriptors (concentration, time-pressure and disturbance levels) were well depicting possible reasons for their unavailability for communication. Participants did not propose any additional descriptor they would like to use to describe their status. A need, however, was expressed to assign different importance levels to the descriptors. We noted that while for some participants (e.g. employees of the financial department) time-pressure was considered to be the most crucial descriptor, for others (e.g. researchers) concentration would be the most important one. Participants generally disliked describing their availability status through textual messages entered via StatusME. Those messages were perceived as either uninformative (messages like 'busy' or 'working') or otherwise possibly threatening their privacy as they could be wrongly interpreted or misused by others.

Participants liked when their status was presented in an abstract and graphical way. Such a representation would allow them to (i) remain ambiguous about their own state and manage their time according to their needs and (ii) adapt the meaning of a status representation dependent on who was interrupting them and for what reason. Furthermore, an abstract representation was likely to hide situations, in which participants forgot to update their status as it was possible that the same status description was adequately representing different activities (e.g., high concentration can equally refer to writing a report and also describe attending a tele-conference).

Finally, participants liked to display their present availability status together with activities they planned for the future (e.g. indicating that one is available for the next 30 minutes and then has a meeting). They also thought that some activities, such as meetings or business trips could be automatically indicated as such activities are generally known to their co-workers and unlikely to raise any privacy concerns. However, participants wanted to always have a possibility to overwrite this information in cases when their plans changed or they preferred to conceal them.

> *"These two (AvBox and StatusME) are dedicated to set availability. I can say through them:' I am concentrated but if you have something urgent come for few minutes'. This one (Outlook Calendar) is too complicated for that. With it people never know if they can come for few minutes or not. Especially if I block my time without specifying the reason and can still be available… You might also be free and suddenly you are interrupted and need to do something else – you are not immediately updating your Outlook Calendar about it. This is why it seems so unreliable. You simply need more information besides whether someone is in the office or not."*

> *"These two (AvBox and Outlook Calendar) give you more freedom in expressing what you do. You can always say that you are unavailable because you are concentrated getting the highest score in Tetris. With this one (StatusME), you have to think about a perfectly acceptable message or a perfectly acceptable activity. You can't write that you are browsing for your holidays while having coffee. You write about things that are acceptable at work and if you do something that is not acceptable you simply don't write about it. It invites to enter an untrue but perfectly acceptable status."*

> *"With those two (Outlook Calendar and AvBox), I don't have to provide specific information about what I am doing right now. I can do that with StatusME and that specific information can be used against me… It might invite comments, like: Have you been doing this or that for so long? It leaves traces."*

Relationships between **Visibility**, **Awareness** *and* **Accountability**

Participants reported that the more effort they put into setting their availability status the more they expected their colleagues to comply with it. Therefore, they repeatedly mentioned that the system should reinforce *Awareness* about their status and also wanted to know by whom and how often their status was checked. Lack of such possibility in the evaluated systems made them feel that they might have been setting their status without any guarantee that it would be consulted. Moreover, participants stated that information about who was checking their status and who was not would allow them for better accountability. They could differently treat people who consulted their status many times and then decided to come and those who did not consult it at all. Furthermore, they wanted a system to allow them to clearly indicate to their colleagues whether the communication moment was appropriately chosen.

"In these two (AvBox and StatusME) whatever you input becomes an output and your benefit depends on it. If you enter a vague message or just slide the availability slider, you know that others can't interpret it. If you put more explanation, others can use to see if they can interrupt you or not. There is a personal information available here, easy to interpret, which increases my chances to understand what someone is doing and being more successful in my attempts to reach that person. In this one (Outlook Calendar) there is no possibility to personalize my status, unless I give someone full access to my calendar and this happens very rarely. The automatically generated message might be easy to interpret but is not useful; I can only see that someone is busy."

"(about AvBox and StatusME): I said to them (interruptors) that my status shows that I am concentrated but they would say to me: Oh well, I am already here, so I am going to ask this and that. There is no punishment for them when they misbehave. They don't get the feedback of what is the consequence of their behaviour. I would like to show them that they were not appropriate, that they did something bad when they didn't respect my status. I like the philosophy of Outlook Calendar more: there you can look into my agenda and then ask me whether within the time that is already available, I could meet you. It leaves the initiative with the one who is looking for the contact and then I can respond to it. In those two the initiative is all in my hands, I have to set them up even for the cases when there might not be any interruption."

Questionnaires

From the analysis of the interviews we could already see that achieving a successful level of *Visibility* might not guarantee for a system to become *socially translucent*. Our last step was to analyze data gathered through questionnaires and test what causal relationships could be seen between the *Social Translucence* constructs in the systems that were tested in this study.

Questionnaire data were analyzed using a Structural Equation Modeling (SEM) technique (Partial-Least Squares - PLS). SEM techniques, like LISREL and PLS, aim at testing causal relationships between latent constructs (e.g. *Visibility*) that were measured through a set of individual scales and, at the same time, being able to assess the factorial validity of the assumed constructs through confirmatory factor analysis techniques [17]. PLS has lately gained increased interest due to its ability to cope with exploratory and confirmatory analysis, and its minimal sample size requirements as compared to LISREL. PLS heuristics suggest a minimum sample size of ten times the number of indicators of the largest latent construct in the model [17]. Since all latent constructs in our model were measured through 3 individual scales our sample size of 30 cases (10 participants x 3 systems: AvBox, StatusMe and Outlook Calendar) was considered adequate.

Two alternative models were tested. In model 1 *Visibility* showed a significant impact on *Awareness* (it accounted for 24% of variance in awareness data with a β value of .49), but the link between *Awareness* and *Accountability* was weak (explained variance is only 15%). This was reinforced by model 2, which showed that by adding *Visibility* as a direct predictor of *Accountability,* a substantially larger amount of variance could be explained and *Visibility* became a stronger determinant of *Accountability* than *Awareness* (Visibility β=.40, Awareness β=.20). The analysis also showed that the relation between *Visibility* and *Awareness* ($F_{2,28}$=1.645928, p<.01) and *Visibility* and *Accountability* ($F_{2,28}$=1.674766, p<.01) were marginally significant (the failure to reach significance could be explained by the small sample size of the study). There was, however, no significant relationship between *Awareness* and *Accountability* detected ($F_{2,28}$=0.727661; n.s.). Note that the proposed causality was only a conceptual assumption that we as researchers put into the model; it cannot be validated with the current study.

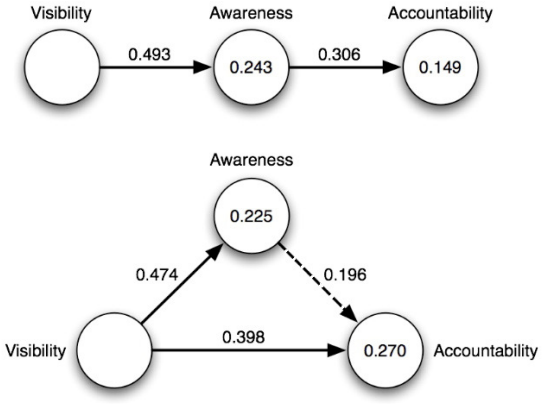

Figure 7: Two alternative Partial Least Square Models reflecting possible relationships between *Social Translucence* constructs. Note that by adding *Visibility* as a direct predictor of *Accountability* (Model 2) we account for substantially larger amount of variance and *Visibility* becomes a stronger determinant of *Accountability* than *Awareness*.

DISCUSSION

This study aimed at answering two questions: (i) what is a successful way to achieve *Visibility* of one's communicative state in systems supporting communication at work and (ii) what are the possible relationships between the three *Social Translucence* constructs: *Visibility*, *Awareness* and *Accountability*.

Achieving Visibility

The results of this study suggest that to achieve a satisfactory *Visibility* level to people's communicative state systems should provide means allowing people to contextualize their availability status. Contextualized status indication is likely to allow co-workers not only to see that their colleagues are unavailable for communication but also to understand why they are unavailable. The three proposed status descriptors: concentration, time-pressure and disturbance levels seem to adequately capture the different reasons behind different communicative states. In line with findings of Erickson and Kellogg [12], we also found that an abstract, graphical status representation that was entirely dedicated to announce availability seemed to leave sufficient space for ambiguity in how people present themselves to others and at the same time was not considered to be privacy threatening.

Moreover, a manually set availability indication was perceived by participants as more believable comparing to the automatically generated status. Nonetheless, participants wanted the system to combine the automatic and the manual availability indication as already previously suggested in [23, 28]. They wanted the system to automatically indicate 'generic events' such as meetings, business trips, etc. based on the content of their agendas. At the same time the system should at all times allow them for manual correction of that automatically generated status allowing them to set their communicative borders so they would reflect their actual rather than planned activities.

Relationships between **Visibility**, **Awareness** *and* **Accountability**

Similarly to Milewski and Smith [23], this study has also shown that people have an inherent motivation to indicate their availability in order to achieve sufficient *Visibility* of their communicative state. However, we also found that despite that motivation, people would still frequently forget to update their status after their communicative state changed. The feedback mechanisms included in the designs (LED-lights on AvBox and always-on-top property of StatusME) were not successful in reminding participants that their status is outdated. We also saw that in our study *Visibility* became a dominant predictor of *Accountability*, with no significant relationship between *Awareness* and *Accountability*. Based on the study results we can confirm that, in order to for systems supporting mediated communication to be successful, social cues regarding people's availability need to be made perceptible and reliable. We, further, argue that achieving successful level of *Visibility* does not guarantee that a system would become *socially translucent*. Given the fact that we looked at *Awareness* as 'one-way Awareness' rather the mutual, reciprocical *Awareness*, we can conclude that such 'one-way Awareness' is also insufficient for a system to become *socially translucent*. Therefore, we propose that to effectively invoke *Social Translucence* it is necessary to stimulate mutual, reciprocical *Awareness* by, for example, providing people with information about who is consulting their status and who is not. Displaying such information is likely to enable co-workers to be more confident in holding their colleagues accountable for untimely communications. The next step in this research is to empirically examine how mutual, reciprocical *Awareness* can be effectively created, so that it leads to supporting *Accountability* and creation of new social norms and behaviours in systems supporting mediated communication.

CONCLUSIONS

In this study we explored the implications of *Social Translucence* for designing systems supporting mediated communication at work. It had a two-fold objective: testing what is a successful way to achieve *Visibility* of one's communicative state and examine what are the possible relationships between the three *Social Translucence* constructs: *Visibility*, *Awareness* and *Accountability*.

We saw that, to improve *Visibility*, *socially translucent* systems should support people in presenting their availability status in contextualized yet abstract manner. A contextualized availability status was perceived as more informative compared to the generic availability information and its abstract, graphical representation that was entirely dedicated to announce one's availability seemed to leave sufficient space for ambiguity in how people present themselves to others.

Using modeling techniques we saw that while *Visibility* had an impact on *Awareness* and *Accountability* there was a weak link between *Awareness* and *Accountability*. Based on these results we argue that in order to design *socially translucent* systems supporting communication at work it is not sufficient to provide mechanisms allowing for expressive and contextualized visualization of one's availability status, but it is also necessary to introduce mechanisms stimulating mutual, reciprocical *Awareness*. Such mechanisms are likely to lead to *Accountability* — creation of new socially responsible norms and behaviours in systems supporting mediated communication.

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