Audio vs. Chat: The Effects of Group Size on Media Choice

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Abstract

The increasing usage of audio and chat communication in private and commercial cooperative settings requires new insight into choosing the appropriate media for collaborative tasks. The paper presents the results of two series of experiments comparing audio and chat communication with varying group sizes. The experimental data indicates that chat scales up better to an increase in group size than audio. We propose that the media richness theory appropriately predicts the productivity of small groups, while the media characteristics proposed by the theory of media synchronicity as well as media speed can be used to predict larger group productivity.

1. Introduction

Chat-based instant messaging programs have become an integral part of the communication in private life [1, 2]. These clients are also used in commercial settings [3]. The same is true for Voice over IP software. This software allows audio conferencing calls using internet connections. Skype, an integrated voice and chat program, using a proprietary protocol has over 100 million registered users, allowing free calls inside the network and cheap calls to normal telephone lines. A further increase of usage will be generated by the ongoing trend towards transparent VoIP. It allows the usage of seemingly ordinary telephones over the internet structure, opening new fields of application for less computer enthusiastic users. All these emerging technologies support conferencing, enabling groups to cooperate easily. This offers new possibilities especially for private users or small companies, which were up to now unable to afford the expensive technology required for multi-user conference calls or synchronous chat conferences.

These new possibilities lead to new 'media choices': What is the appropriate communication media for a given situation? Previous research theorized on the relationship between task type and appropriate media choice. Theories like the media richness theory [4] or the social influence model [5] are widely used but have been developed before the diffusion of modern internet technologies. More importantly, their applicability has been recently challenged [6, 7]. This inconclusive picture has led us to study the effects of group size and task on the media between voice conferencing and chat conferencing, culminating in two series of experiments conducted in November 2004 [8] and November 2005 [9]. The focus of the experiments lied on small groups of private or corporate users, who want to cooperate on a small task. These tasks are characterized by spontaneous occurrence, adhoc group compositions and limited group history. The availability of VoIP offers new possibilities to cooperate, because there is no need for expensive multi-point teleconferencing equipment.

This paper is organized as follows. Following the introduction, section two introduces theoretical and empirical research on media choice. This research will then be the basis for a set of hypotheses in section three on the relationships between group size and the success of the collaboration while using audio or chat. Section four introduces the design of the experiment and section five examines the results. The paper closes with the interpretation of the results and derives recommendations for the media choice of audio or chat.

2. Media choice: theories and empirical results

2.1. Media choice in small groups

The media richness theory by Daft and Lengel [4] is the most popular theory in the area of media choice and is based on the postulation of a rational selection of media. The 'richness' of a medium depends on how well it provides for four factors [10]: language variety, multiplicity of clues, personal focus and feedback. These factors are used to rank the 'media richness' of media channels. The more equivocal and ambiguous the task, the more richness is needed. The media

richness theory claims to be applicable to 'groups', but has been mostly applied to very small groups (with up to four members). Despite this shortcoming, it still remains the most popular theory regarding media choice of small groups.

While the media richness theory describes the rational selection of media and its effects, the social-influence-model by Fulk et al. [5] describes media-choice as a decision based not only on inherent characteristics of a medium, but also on social and subjective factors. The views, judgements, trends and behaviours of other users and especially other group members influence the individual's choice of media usage. Another difference to the media richness theory is the assumption that the users reflect on their past experiences with a medium, and then use these experiences to create assumptions for future use. Thus the satisfaction of users is not only based on their perceived usage of a media, but also on social factors.

There is substantial empirical research into media choice, primarily based on those theories. But even after hundreds of experiments the data is still inconclusive and there are no solid conclusions for the overall topic. Fjermestand and Hiltz [11] conducted a meta-study in 1999 examining more than 230 articles. They observed that most experiments do not show any significant results, especially when comparing Face-to-face (FtF) and Computer-mediated communication (CMC) groups. Only 20 % of the experiments showed any significant results. Furthermore, these results contradicted each other occasionally. More recent studies by Powell et al. and Weber [12, 13] also fail to lift this inconclusive picture. Dennis et al. [14] observed that most of the studies also focus on the perception of the users, instead of the actual media use and its effects.

Furthermore, most research is focussed on dyadic groups, trying to grasp the effects of media choice in regard to certain task characteristics. There are surprisingly few experimental studies comparing audio and chat. Studies by Kinney and Watson [15] and Suh [16] show that chat groups required a longer time regardless of the task. There was no significant difference in satisfaction between the audio and chat groups. The study of Valacich et al. [7] contradicts these results. Groups using chat finished faster than groups using audio, regardless of the task. The chat groups also showed significantly less process satisfaction than groups working with audio communication. Thus, even for dyadic groups there is no conclusive picture regarding audio and chat. In the study of Bos et al. [17] groups of three persons were requested to work on a variation of the Prisoner's Dilemma, a task with high equivocality. Audio groups solved the problem significantly better than the groups using chat. Graetz et al. [18] observed groups of four working on an equivocality task requiring information sharing with a hidden profile problem. Chat groups took significantly longer to solve the problem than audio groups. This was attributed to problems in coordinating the member input and the verification of the information. Burke and Aytes [19] observed groups of four using different communication media over a four week period. The groups using chat or audio were both able to maintain cohesion and satisfaction. During the first phase of the experiment the chat groups expressed less satisfaction and cohesion, but were able to improve these factors over time. They invested effort to compensate for the low media richness of their medium. Altogether there is very limited data regarding the effects of media choice for groups using audio or chat. Furthermore, some of the experimental results contradict each other.

2.2. Media choice and group size

Studies of conventional brainstorming, such as the studies by Diehl and Stroebel [20, 21] and Mullen et al. [22], have shown that an increase in participant numbers can decrease the overall productivity of groups. This effect is attributed to productivity blocking, which occurs when group members cannot participate because they have to wait for other participants to finish their input. This was partially contradicted by Nunamaker et al. [23] and Gallupe et al. [24], who have shown that electronic brainstorming tools can limit these issues so that additional group members benefit from the productivity. Nunamaker et al. [25] broadened the view of factors influencing the productivity by including factors such as high effort, information overload and the failure to remember information. These factors are not considered by the media richness theory. The theory of media synchronicity [6] incorporates these aspects. Media choices are grouped along five factors:

- **immediacy of feedback** determines the ability of the medium to support receivers of a message to give immediate feedback to the sender;
- **symbol variety** describes the scope of possible communication ways available to the user in a communication process;
- **parallelism** is the number of concurrent communications in which the user can participate at the same time;
- **rehearsability** describes the ability of the medium to provide a preview of communication fragments before they are sent to the communication

partners, thus allowing the sender to change the content;

- **reprocessability** is the capability of the medium to support an easy later reuse of material by the receiver.

Some of these factors, such as immediacy of feedback and parallelism, are mutually exclusive. Therefore, media channels cannot be ranked because no media has the highest values in all factors. Thus, the selection of media channels should be done according to the most needed factors. Another important aspect for the selection is media speed, as described in.[26]. Media speed is the overall capacity of the media to communicate information. Audio and chat differ in this aspect insofar, that audio communication is much faster, while chat communication is slower and therefore encourages a higher efficiency.

We are not aware of any experimental research directly comparing audio and chat for different group sizes or even for studying both media for larger groups at all. This is surprising since conferences with five or more participants have become increasingly popular both in private and business settings[1]. An experiment with a medium sized group has been conducted by Valacich et al. [27]. They compared groups of five using audio conferencing to those using an electronic meeting system (EMS), such as GroupSystems, which provides a tool similar to chat, but including structuration support. They observed that for tasks with low equivocality, EMS-supported chat groups created significantly better and more ideas than the audio groups. Valacich also found that the EMS supported groups were more satisfied with the precision of the communication method than the audio using groups. The results of this experiment and other experiments conducted with electronic brainstorming systems can only serve as an indication due to the support of the EMS, that is, the results might not be the same working with unsupported, plain chat communication.

3. Research model and hypotheses

3.1. Research model

Depending on group size, different factors influence the productivity of groups using audio and chat. Blocking issues, missing parallelism, information overflow and many more issues are increasingly hampering the work of group members with rising participant numbers. Small groups will not suffer from these problems as much. Rather fast feedback and converging to a shared understanding are crucial (for equivocal tasks) [8]. *Therefore, we propose that the media richness theory appropriately predicts the productivity of small groups, while the media characteristics proposed by the theory of media synchronicity as well as media speed can be used to predict larger group productivity.* This paper strives to establish an empirical basis for this proposition. In the light of Dennis' [15] criticism of prior experimental research, we will not only measure success by the (subjective) user satisfaction but also by (objective) productivity.

In order to be comparable to prior work (such as the open-ended questions in the works of Diehl and Stroebel [20, 21] and Gallupe et al. [24]), we have selected a task of equivocality.

3.2. Hypotheses

The work presented here builds on prior publications of our work on comparing audio and chat conferencing for groups of four [8]. In order to give a coherent overall picture, we briefly summarize the hypotheses (and in a subsequent results section, the results) of those prior studies. Then we propose hypotheses on the original contributions of this paper: media choice for groups of seven and the effects of increasing group size.

Media choice and tasks regarding groups of four

The media richness theory postulates that for any task there is a medium with the appropriate amount of media richness. According to the media richness theory, audio groups should show a higher productivity when working on tasks of equivocality, because the media offers higher media richness. This higher media richness should help alleviate the ambiguity of the task. Previous research into audio vs. chat communication in dyadic groups partially supports this view. This leads us to the following hypotheses regarding the productivity.

H4.1: Audio groups with four members show a higher productivity than chat groups when working on the task of equivocality.

Media choice in groups is a social process. According to the social-influence model, the choice is affected by the past experiences of the user with the medium and the expectations for future uses. Audio communication, especially in dyadic settings, has been in use for more than a hundred years. The user effort is limited to speech and therefore very small. Chat communication, on the other hand, involves a structured, typed input, which requires more effort

[1] One reason may be research economics: Studying larger groups requires a larger number of study subjects.

than talking. The effort and familiarity with the medium is a key component to the user satisfaction. Therefore, we propose that the user satisfaction should be higher for groups using audio.

H4.2: Audio groups of four working on a task of equivocality show higher satisfaction with the medium than chat groups.

Media choice and tasks regarding groups of seven

The parallelism of the chat communication channel, as described by the theory of media synchronicity, becomes increasingly important with an increase in group size. Also, the benefits of immediacy of feedback by the audio medium is limited in effectiveness due to the problem that only one person can give feedback at any time, blocking the feedback of the other five persons. Furthermore, the reprocessability and rehearsability support the chat users in their work, while the audio users have no access to these support characteristics of the medium. Thus, we believe that the chat channel should allow the communicating group members to perform better than the audio channel in both settings.

H7.1: Chat groups with seven members show higher productivity than audio groups when working on the task of equivocality.

Audio and chat communication react differently to an increase in group size. The low parallelism of the single communication channel of audio communication will become even more severe. Also, the familiarity with the audio medium learned from telephone usage will become less important as few people have a long history of large audio teleconferences. The group members have to introduce structure into their communication (e.g., turn taking mechanisms) in order to coordinate the input of all group members. Thus, the satisfying aspects of audio are reduced with an increase in group size. The chat communication channel remains nearly unaffected by an increase in group size. Only information overload is worsened due to an increase of input from all group members. Therefore, we propose that for groups of seven, chat communication will become more satisfying than audio communication.

H7.2: Chat groups of seven working on a task of equivocality show higher satisfaction than audio groups.

Media choice and increase in group size

Further, the productivity of the audio groups will be hampered by the characteristics of the medium itself. With an increase in group members, turn-taking will consume even more time. Additionally, the requirements on the user in order to remember all comments from all group members will increase, thus forcing the user to concentrate more on the communication task instead of the actual work. Blocking issues will become more severe. We also speculate that the aspects of higher media richness of the audio channels may become dysfunctional if the recipients are not able to process all the rich information in an appropriate manner. The larger the group is, the larger is the set of social clues each member has to memorize in order to process information.

The chat communication channel is less hampered by these problems. Here the only negative effect of the increase in group size is the information overload factor, which is reduced by the possibility to look up information in the chat history function.

Thus we propose:

H4vs7.1: Audio groups experience a higher impact on their productivity than chat groups for tasks of equivocality if the group size is increased from four to seven.

As mentioned before, audio communication does not cope well with an increase in group size due to the missing parallelism. Therefore, the members will be less satisfied with their medium by an increase in group numbers. Chat groups won't be hindered by their medium in regard to the ability to input data, but will exhibit an increase in information overload, due to the high speed of communication. We believe that the frustration of waiting for the opportunity to communicate outweighs the potential information overload. Thus we propose:

H4vs7.2: Audio groups experience a higher impact on their satisfaction than chat groups for tasks of equivocality if the group size is increased from four to seven.

4. Methods, design and experiment

4.1. Methods

In order to profit from previous research experiences, maintain comparability and to avoid fracturing the existing research on media choice theories even further, we used a proven experimental task: "the automatic post office of the future" experiment by Olson et al. [28], which is a task of equivocality.

4.2. Design

The "automatic post office of the future" experiment asks the participants to design an automatic machine, presenting the post office of the future. The

design has to be functional, understandable and practicable. This task has a low degree of uncertainty (all the information needed is provided in the task sheet), but a high degree of equivocality, due to the open-ended nature of the task. Therefore, the task requires not only the communication of the ideas and thoughts, but also the creation of a shared understanding of the scope of the task and the priorities and requirements of the design.

All participants of experiments with this task received a translated task sheet based on the experimental description used by Olson et al. [28], which was slightly adapted to fit the Swiss context. The groups were allowed 45 minutes to read the instructions and work cooperatively on the design. They were encouraged to create a good design and to finish as quickly as possible.

4.3. Experiment

General setup

All experiments were performed with paid volunteers, each receiving 25 Franks (16 Euros). They were recruited from the student body of our University. The group members varied widely in both gender and field of study. 80 students participated in the first experiment in November 2004 [8, 26]; the second experiment in November 2005 [9] had 140 participants. Students were only allowed to participate once. Each group member was led into a separate room, equipped with a standard notebook with mouse. All users were allowed to use the Netmeeting virtual Whiteboard in order to allow shared material to be available for output purposes. The chat groups used one Netmeeting chat tool for communication, while the audio groups were equipped with high quality headsets. The audio groups consisting of four members used Skype software, while the audio groups with seven members used Teamspeak, as Skype supports a maximum of 5 concurrent users.

Gathering of Data

All participants received a questionnaire to ascertain satisfaction with the communication medium. We used the SUS (system usability scale) questionnaire [29] for this to maintain comparability with other experiments. This questionnaire incorporates ten questions with a 5 point Lickert scale. The specific design of the questionnaire lowers the effect of random form completion. The output is a value between 0 and 100, with 0 being an unusable system and 100 a perfect system. The time used for the task was computed post-hoc by analyzing the communication data in order to prevent inaccurate timing by the experimental leaders. We used the timestamps of the logs for the chat groups and an audio program to compute the communication time of the audio groups. The outcome of the design task was rated by five experts without knowledge of the medium used. The high number of participants required that the two experiments be one year apart. Thus, the raters knew the group size, but not the media treatment.

Measuring productivity requires a quantitative measurement of the quality of a design. Building on established lines of creativity research [30], the quality of the design was rated by the number of distinct ideas captured in it. In a design, ideas are represented by features. The raters agreed on a benchmark list of features required for the successful operation of an automatic post office. These features were weighted into 4 categories with different priorities (critical features worth 8 points, important additional features worth 4 points, additional features worth 2 points and marginal features worth 1 point). The raters showed a high interrater agreement (Krippendorf alpha=0.713) for the rating of the design results of the groups of four, while showing a lower but still acceptable interrater agreement for the groups of seven (Krippendorf alpha=0.587), with 0 being no identical ratings at all and 1 being only identical ratings of all five raters at the same time. We believe that this method is more appropriate for the purpose of this study than the original method used by Olson et al. in [28]. To even out jittering effects of individual ratings we used the mean value of all five raters. To check for anomalies during the rating, we conducted a re-rating of the groups of four after rating the groups of seven. The results remain the same, resulting in only minimal changes. To further check for anomalies, we also computed all mathematical tests with the individual ratings instead of the mean value, which showed the same results but with a more pronounced jitter.

Productivity is calculated by dividing the rated result of the group work by the time needed to complete the task and is expressed by rating points per minute.

Statistical methods used

We used one-tailed T-Tests to calculate the effects of media choice on productivity and satisfaction for a constant group size and the effects of group size for a constant medium, because there was one independent variable with only two possible values (audio vs. chat, groups of four vs. groups of seven). To calculate the interactions between group size and medium, we used 2x2 factorial ANOVA. While the number of data

points might seem small, each data point incorporates the mean value and output of four or seven group members. Furthermore, each rating of the post office designs is also a mean value of the five raters. Therefore, we believe that the normal distribution is inherent inside the data due to the compensating effects of team work and joint rating. For the computation of the effect size we used partial Eta squared.

4.4. Limitations

Group size as a key variable first became apparent during an in-depth analysis of the behavior of groups of four. Tests of groups of seven were not planned at that time. Thus, we had to conduct a series of experiments one year apart and could not randomize between both group sizes. Furthermore, conducting the whole experiment for both group sizes at the same time would have required 440 participants – such a high number of students was not available.

This could result in participants being much more apt with the media concerned. But due to very similar SUS ratings for ease of use (4.4 points in 2004 and 4.34 point in 2005 out of five possible points for ease of use) we believe that we can assume overall constant abilities. A new study by George et al. [31] supports this view, showing the same perception of media richness in 2004 as the ratings by Daft and Lengel in 1987. The introduction to the software was done using exactly the same documents, test procedures and words by the experimental leaders.

We furthermore had to switch tools to study larger groups, due to limited user numbers in Skype. Teamspeak was pre-configured to work with voice activation instead of button toggling. The differences in functionality and quality between both audio tools are negligible if used on a high-bandwidth LAN.

The subjective SUS-rating for the satisfaction also incorporates ease of use views on the software. Due to technical limitations we were not able to create a fully transparent audio conference. But one of the key advantages of VoIP software is the availability of free conference calls without the need for expensive conference call enabled telephony systems. Thus we believe, that this scenario is more valid for future usage.

We were also limited in the amount of tasks in order to maintain feasibility in the size of the studies. We also conducted an experiment with a task of uncertainty, which is not part of this paper. Results can be found in [8, 26] for groups of four and [9] for groups of seven. We think that tasks of uncertainty and tasks of equivocality cover most of the communication tasks occurring. Since both tasks center around different activities (information dissemination vs. cooperative group design) we cannot compare them directly; thus, we are observing the effects of media choice for both tasks in parallel. Also the duration of the experiments is very limited. While we believe that long-term studies of groups might show different results we agree with Kinney and Watson [15], that such short interactions are also part of the typical business work processes.

Another limitation of this paper is the focus on the productivity and satisfaction ratings. Further information will become available in the future after detailed analysis of the data. The sheer amount of data gathered prevented the inclusion of this analysis in this paper due to the extensive amount of time required to transcribe the audio logs.

5. Results

5.1. Results for the groups of four

The results of the groups of four will be presented here in summary. For further information see [8, 26].

Productivity

The audio groups are significantly more productive than the chat groups ($t(18)=2.668$; $p<0.01$) for the design task. Thus, hypotheses H4.1 is supported fully by the data. The audio groups are significantly more productive than the chat groups and are also much better in identifying and including critical features than the chat groups.

Satisfaction

The audio groups are significantly more satisfied with their communication media than the chat groups ($t(18)=2.068$; $p=0.027$). Thus, hypothesis H4.2 is supported by the data.

5.2. Results for the groups of seven

Productivity

Regarding the productivity, there is also no significant difference ($t(18)=0.084$; $p=0.467$) between the chat groups (1,48 feature points per minute; STD 0.166) and the audio groups (1.49 feature points per minute, STD 0.316). Therefore, Hypotheses H7.1 is not supported by the data.

The next section will analyze whether an increase of group size has a significant impact on collaboration success with different media.

Satisfaction

Engaged in tasks of equivocality, chat groups (with an average SUS value of 77.46 (STD=5.02)) are more satisfied than the audio groups, with a mean SUS value of 71.82 (STD=8.36). This difference is significant (t(18)=1.829; p=0.042). Thus, Hypotheses H7.2 is supported by the data.

5.3. Impact of increased group size on productivity

Audio groups show a decrease in productivity by 13% of the mean value due to the increase in group size, but this effect is not significant (t(18)=1.306;p=0.104). The chat groups, on the other hand, show a significant increase in productivity by 16 % of the mean value (t(18)=-1.754; p=0.048) due to the increase in group size. To further observe the combined effects of both group size and media choice on the productivity, we performed a 2x2 factorial ANOVA test.

The groups show very different productivity with groups of four, while performing virtually identical for groups of seven. The selection of the medium influences the productivity significantly (F(1,36)=4.884; p=0.034). It is responsible for 12 % of the variance in productivity regarding the sample. The size of the group is not significant for the change (F(1,36)=0.003; p=0.955). The combination of media choice and group size are also significant for the change in productivity (F(1,36)=4.457, p=0.042). The combination is responsible for 11 % of the variance in productivity of the group members. The selection of the medium influences the productivity of the group (figure 1). But with an increase in group size to seven members, the selection of the media becomes void. While audio groups clearly outperform chat groups in group sizes of four, chat groups improve their performance with the increase in group size, arriving at the same productivity as the audio groups.

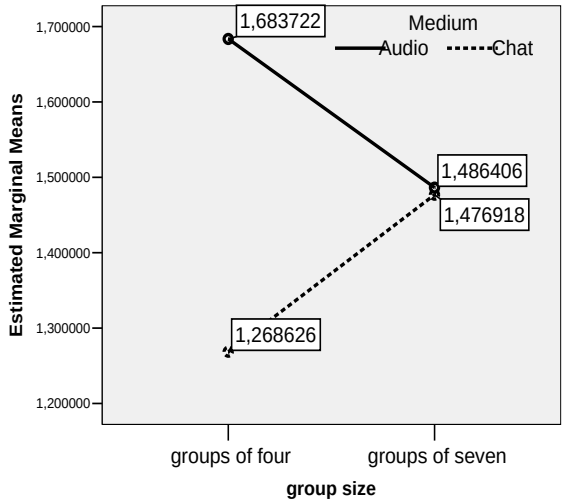

Figure 1: Rating points per minute in regard to medium and group size

Thus H4vs7.1 (“audio groups experience a higher impact on their productivity than chat groups for tasks of equivocality if the group size is increased from four to seven“) is fully supported by the data.

5.4. Impact of increased group size on satisfaction

Audio groups were significantly more satisfied working in a group with four members than in a group with seven members (t(18)=5.842;p<0.01; difference between mean values: 16.87 SUS points).

The chat groups showed the same indications, but with a lesser degree of dissatisfaction with the increase in group size. Chat showed a significant decrease in satisfaction (t(18)=2.207; p=0.021; difference between mean values: 6.04 SUS points).

While both media show a trend towards dissatisfaction with an increase in group size, the trend is far more pronounced with the audio groups than the chat groups. To further explore the factors influencing the satisfaction, we decided to run a 2x2 factorial ANOVA test, focusing on group size and medium as the factor.

There is a very strong dependency of the user satisfaction in regard to the group size (F(1,36)=33.172; p<0.01). This amounts to 48.0% of the variance in satisfaction of the group members. The selection of the medium does not show a significant impact on the SUS rating (F(1,36)=0.522, p=0.909). But there is also a highly significant effect created by the combination of group size and medium (F(1,36)=7.417; p=0.01). This amounts to 17.1 % of the variance in satisfaction regarding the sample. Thus, the group size is important to the satisfaction of the users (figure 2). But with the selection of the appropriate medium the dissatisfaction of the users with a larger group size can be reduced.

Therefore H4vs7.2 (“audio groups experience a higher impact on their satisfaction than chat groups for tasks of equivocality if the group size is increased from four to seven”) is fully supported by the data.

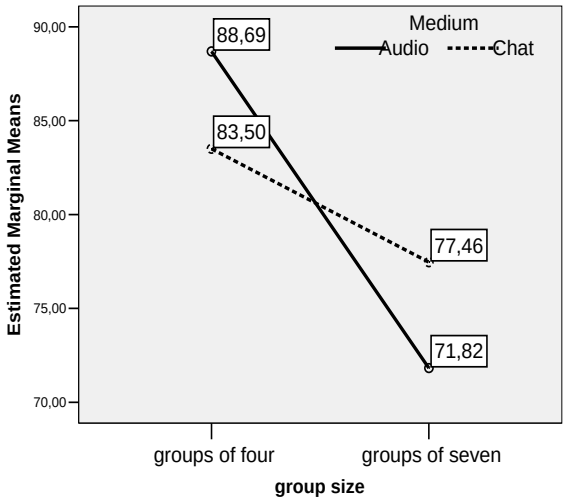

Figure 2: Influence of group size and medium on satisfaction

6. Discussion

6.1. Productivity

While audio groups show a significantly higher productivity than chat groups with four members, they failed to achieve better results than the chat groups when group size is increased to seven. A larger group size seems to hinder the creative process of the audio groups which have to share the communication channel. Thus, the audio groups behave similar to the FtF groups of the productivity blocked brainstorming groups. These process losses are so large that adding three new members to an audio group with four members does not generate any benefit, i.e., is a waste of resources. Chat groups, on the other hand, thrive with the increased input of larger groups since they are able to express ideas in parallel. This effect should offset the overall slower media speed of chat shown in [26]. The chat groups show a significant improvement of performance with the larger number of group members. This enables them to communicate more ideas in the given time, which leads to better results when compared to groups of four.

6.2. Satisfaction

The data shows clearly that with increasing group size the satisfaction with the media changes. While it is not in itself surprising that smaller groups are more satisfied, the interaction effect of group size and media is noteworthy. Audio groups are clearly more satisfied with their media when working in groups of four. But when the group size increases to seven users chat becomes the more attractive medium, even if it requires additional effort from the user. Therefore, it can be concluded that groups consisting of five or six users are the threshold for comparatively satisfied distributed audio groups. Group sizes above this require a non-blocking, parallel communication medium to prevent users from becoming frustrated. With the right selection of the media, the erosion of satisfaction with an increasing number of group members can be limited.

6.3. Overall interpretation

The experiments have shown clearly that chat scales up better to increasing group size than audio. While audio groups fit the requirements for small, cooperative groups, the limiting factor of a single speaker in conjunction with multiple, passive listeners hampers both the productivity and satisfaction in larger groups. Here the benefits of chat communication with the possibility of parallel, written communication is able to compensate the additional effort required to write.

Thus, our results support the propositions of the media richness theory only for groups with four members. In equivocal tasks a richer medium leads to more satisfaction and productivity. This is in accordance to our research model, indicating that the media richness theory might be useful for small group sizes.

For larger groups the media richness theory fails to explain the loss of productivity of the audio groups and the increase in productivity of the chat groups. Therefore, factors other than media richness have to be responsible for the changes in productivity.

The evidence in the data supports the emerging theory of media synchronicity [10] which introduces parallelism as a key factor for media choice, thus incorporating the features needed to prevent productivity blocking. Due to these results, we think that the parallelism of chat communication, especially when compared to a non-parallel medium like audio, is the primary factor for the enhanced productivity of larger groups.

Furthermore, the media speed of the two media changes with the numbers of participants. Generally, humans write slower than they talk, but some read faster than they talk. The more parallel a group communicates, the less important is slow information production and the more important is fast information reception (as everybody has to consume all produced information). In another paper [26] we show that written communication produces more important clues and ideas per 100 words than audio communication.

This observation strengthens a preference for chat in situations where the capacity to consume information is more important than the capacity to produce information. Large groups engaged in true collaboration (in contrast to pure broadcast of information in many business meetings) are in exactly this situation.

Smaller groups do not profit from chat to the same degree, due to smaller blocking issues and less benefits from the written input. They profit rather from improved feedback, multiplicity of clues, personal focus and language variety of audio.

Furthermore it is interesting to observe that users are obviously able to recognize efficient means of communication. The requirement to listen passively without any chance of input to other group members frustrates the members of large audio groups. While chat groups also show a lower satisfaction with the communication process for an increased group size, they clearly are less discontented and thus less concerned with the medium.

7. Conclusion

The selection of the communication medium regarding audio and chat usage in distributed teams should take group size into account. If the group consists of four or fewer members working on a task of equivocality, audio communication should be used. The satisfaction of the users is higher and they show a significantly higher productivity. Groups with seven or more members should use chat communication. The productivity is as good as those of audio groups and the satisfaction is significantly higher. Furthermore, as shown in [8] the chat groups are more efficient in transmitting the critical information pieces required for cooperative work.

Assuming a continuous productivity function, groups with five or six members should use audio communication when working on tasks of equivocality, especially when the focus is on productivity. This measurable increase in output should be communicated clearly to raise the perceived usefulness of the medium and therefore increase the satisfaction of the users. Moderation and explicit turn-taking mechanisms might help untrained users to achieve a more thorough understanding of the communication process and thus feel more comfortable with using the medium.

In conclusion, there is clear evidence that small groups are more satisfied and productive using audio communication, which is easier to use and requires smaller personal effort. With increasing group size, the blocking, non-parallel characteristic of the audio medium becomes a hindrance. Satisfaction and productivity drop accordingly. Chat groups show a higher satisfaction and benefit from more group members in creative tasks of equivocality. Therefore written communication, while cumbersome, becomes the better communication medium for larger groups. Group support systems increase this effect for even larger groups, when moderation of the parallel written channel becomes necessary [25]. Furthermore, distributed groups only benefit from additional members in specific circumstances. Working on a task of equivocality, chat communication can lead to more productivity from additional members. Therefore, it is in some cases counterproductive to increase manpower without the right medium for the right task. Instead, a prudent assignment of group members and communication media along the lines set forth above result in both satisfied group members and high productivity.

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8. References

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