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The Role of Message-Sequences in the Sustainability of an Online Support Community for Older People

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This article presents an investigation of an online support community for older people, analyzing a data set of messages posted over the period of six years. We studied messages that are related to each other which we call "message-sequences". We investigated the content of message-sequences and linked our findings to the level of activity of the online support community over time. We show how certain sequences of messages within the online community are related to the level of activity thus providing valuable insight into the role of message-sequences in sustaining online support communities for older people. We conclude that the mutual exchange of personal information and receiving support after talking about personal problems are basic components for the sustainability of the online community, whereas conversations that go off the topic of the online community seem to be related to a decrease in the level of activity.

1. Introduction

1.1 Problem statement

Online support communities are generally described as online settings in which people who are in a similar life situation exchange factual information and emotional support to help each other (Rodgers & Chen, 2005). A substantial amount of research has analyzed communication patterns within online support communities. However, most research has been focused on the content of online communications (Kanayama, 2003; Maloney-Krichmar & Preece, 2005; Pfeil & Zaphiris, 2007), patterns of relationships and communication activities in the communities (Wright, 2000a; Xie, 2005) and the perception of these activities by members of these communities (Wright, 2000b; Xie, 2005; Pfeil et al., 2009). While these studies provide useful insights into the characteristics and perceptions of online support communities, most of them provide a snapshot view of the community, not taking into account the dynamic changes and conversation patterns over time. So how do online support communities develop over time? Do conversations in these online communities follow specific patterns? If yes, are there any patterns that are related to the increase or decrease of the level of activity within the online community?

Answers to these questions can help us to identify the underlying driving forces of the dynamic changes within online support communities. Especially for online communities that are characterized by a high vulnerability towards trust-breaking behavior, analyzing the communication in respect to its dynamics and temporal changes can give valuable insights into the reasons for community growth and decline. In our paper, we will focus on related and connected messages within an online support community, namely message-sequences. We thereby distinguish between two kinds of message-

sequences: (i) two messages that are posted in timely order are presented adjacent to each other and form a message-sequence, and (ii) one message that refers to a former message constitutes a link between these two messages and forms a message-sequence. Our study focuses specifically on an online support community for older people (aged 60+).

1.2 Objectives

Although plenty of literature is available about the content, use and benefit of online support community in general (Maloney-Krichmar & Preece, 2005) and for older people specifically (Pfeil & Zaphiris, 2007; Wright, 2000a, 2000b), little work has been done so far on the composition of conversations and their relation to the dynamic changes within the online community. We address this research limitation by providing insights into the patterns of message-sequences and their relationship to the overall activity within an online support community for older people. Our overall aim can be broken down into the following objectives:

(i) Identify patterns of message-sequences within the online support community.

(ii) Investigate the relationship between message-sequences and the level of activity within the online support community.

We believe that our case study has a significant contribution to computer-mediated communication (CMC) research as it gives insight into the complex patterns of online supportive communication. Identifying not only the content of supportive communication, but also its dynamics and conversational patterns will help us understand what drives and what hinders the exchange of messages within these communities. If we understand the process of exchanging support in online communication, we can also find out how to nurture it and design online communities that encourage supportive communication.

2. Literature review

2.1 Online support communities for older people

A recent review of studies by Dickinson and Gregor (2006) investigated the impact of computer usage on older people's quality of life. They concluded that the often-cited benefits of computer usage for older people are not based on scientifically sound evidence. Rather than the computer usage itself, they suggest that it might be the social interactions that older people engage in when learning how to use a computer that lead to an improvement in their wellbeing. Overall, they argue that existing research so far fails to provide clear evidence that computer usage does improve older people's wellbeing and more work in this area is necessary in order to derive clear conclusions (Dickinson & Gregor, 2006). However, some studies do claim that online communication and internet usage enhance older people's quality of life and wellbeing (Xie, 2007). Online communities offer older people the possibility to meet others who are in a similar situation and engage in satisfactory social interactions with them (McMellon & Schiffman, 2002). Bradley and Poppen (2003) found that participation in an online community for housebound older people resulted in an increased level of satisfaction with the amount of contact to others among participants, suggesting that online social interactions might be especially beneficial for this target group.

At the moment, email is still the most prevalent communication activity of older people online (Jones & Fox, 2009) but the number of older people using online communities is also growing. Especially for older people who are housebound or who suffer from a specific illness, online support communities offer a possibility to communicate with people who experience a similar situation. Investigating the motivation of older people to use CMC, Kanayama (2003) found that older people value communicating with like-minded people, forming companionships and exchanging social support in

online settings. Wright (2000a) also found that the satisfaction and amount of the exchanged support depends on the size of the social network that a person interacts with and the amount of time an older person spends in these settings. In addition, studies have also been conducted to analyze the actual content that older people exchange in online support communities. Wright (2000b) showed that the support exchanged varied from being informational to highly emotional with people often expressing gratitude and deep satisfaction for being part of the online support community in their messages. Pfeil and Zaphiris (2007) developed a coding scheme for describing different aspects of supportive activities that take place within an online community. They showed that the most frequent activities of older people were to disclose information about themselves and to post messages that nurture a feeling of togetherness.

As outlined above, existing studies give valuable insight into characteristics and content of online support communities for older people. However, as far as we are aware, no work has been done yet in order to investigate the impact of the content that is exchanged among older people on the sustainability of the online support community. Do messages with certain content trigger specific replies? And does the exchange of certain content within online support communities for older people impact on the sustainability of this community? We believe that answers to these questions must be sought in order to understand what makes successful online support communities for older people. In the following, we will review literature concerning the sustainability of online communities in general and discuss their relevance for our study.

2.2 Sustainability of online communities

Researchers are increasingly interested in investigating the development of online communities over time. The focus often lies on factors that raise and maintain the sustainability of online communities. For example, studies have looked at the responsiveness (the extent to which one message within an online community responds to another one) and interactivity (the extent to which one message refers to a previous one and the relation of the previous to another previous message) of online communities (Rafaeli and Sudweeks, 1997; Kalman et al., 2006; Jones et al., 2004). These are important characteristics of online communities as responsive and interactive online communities are believed to be more engaging and beneficial for their members (Rafaeli and Sudweeks, 1997). But what constitutes and encourages responsive and interactive messages?

Himelboim (2008) investigated patterns of reply distributions in political and health Usenet discussion boards. He found that both types of discussion boards showed an unequal distribution of replies among its members, with a few members attracting a disproportional high number of replies. This tendency was stronger for health-related discussion boards than for political-oriented ones. He also found that the skewdness of the response distribution increases with the size of the community (Himelboim, 2008). Focusing on the characteristics of messages, Berthold et al. (1997) found that messages with a medium message length, an appropriate subject line and a statement of a fact have a higher possibility of triggering a response. Joyce and Kraut (2006) found that long initial posts or posts that included a question were more likely to trigger a response. If an initial message contains a question, it is very likely that it will trigger an answer. Also, responding messages are reported to be similar in style and form to the initial post (Becker-Beck et al., 2005), e.g. initial messages that sound negative trigger a more negative response and longer initial posts trigger longer replies (Joyce and Kraut, 2006). However, these findings are based on the investigation of generic online communities with a mixture of topics. Findings from Fisher et al (2006) as well as Joyce and Kraut (2006) suggest that the likelihood of responding to initial messages is dependent on the kind of online community. Both studies suggest that online support communities have one of the highest responsiveness scores and thus are most likely to be sustained over a longer period of time. Table 1 shows a summary of research studies focusing on interactivity and response-patterns in online communities.

Reference	Type and date of online community	Main Findings
Rafaeli & Sudweeks (1997)	10 random Bitnet lists; 12 random Usenet newsgroups; 10 random CompuServe SIGs (all collected in 1993).	10% of messages were coded as interactive; 52.2% were coded as reactive. Interactive messages are longer, more humorous, contain more self-disclosure, display a higher preference for agreement, are more opinionated, and contain many more first-person plural pronouns. Listserv mediated messages were significantly less interactive than either Usenet or Compuserve SIG messages.
Kalman et al. (2006)	15,815 email responses by 144 employees of the Enron Corporation (1998–2002); 115,416 responses in a discussion groups for university students (1999–2002); 40,072 responses posted to answers.google.com (2002–2004)	Around 80% of the responses were sent within the average response latency of that group. Around 97% of the responses were sent within 10 times that average response latency. This tendency was found to be the same for all three datasets.
Jones et al. (2004)	2.65 million postings to 600 random Usenet newsgroups over a 6-month period in 1999-2000.	Users are more likely to respond to simpler messages in overloaded mass interaction. Users are more likely to end active participation as the overloading of mass interaction increases. Users are more likely to generate simpler responses as the overloading of mass interaction grows.
Himelboim (2008)	15 groups of each of the topics ‘‘politic’’, ‘‘health’’ and ‘‘support’’ within Usenet discussion forums between 2000 and 2005 were randomly selected. In each group, only threads that started in October 2004 were selected.	The larger a group is, the more skewed its degree distribution. In practice, the more active a discussion, the less egalitarian its distribution of replies among authors. The structure of a discussion network is affected by the type of information exchanged within it. Factual information invites a more centralized and hierarchical discussion, whereas an opinionated discussion invites relatively more egalitarian patterns.
Berthold et al. (1997)	3000 postings from over 30 randomly selected discussion groups on Internet, Bitnet and Compuserve (ProjectH)	A message triggering a lot of replies has a medium length and an appropriate subject line, and a statement of a fact also enhances the chances of being followed-up. If during an already ongoing thread one introduces a completely new topic, the chances of getting a response are slim A message which does not reference seems likely not to be referenced. Being followed-up when one already participates in a thread is much easier
Joyce and Kraut (2006)	The data come from initial posts made by 2,777 newcomers to six public newsgroups.	Approximately 61% of newcomers received a reply to their initial post, and those who got a reply were 12% more likely to post to the community again. They were more likely to receive a response if they asked a question or wrote a longer post The quality of the response they received did not influence the likelihood of the newcomer’s posting again.
Becker-Beck et al. (2005)	Experimental setting, six groups consisting of four experts cooperated per one of the three modalities (face-to-face, synchronous CMC, asynchronous CMC) in planning a marketing campaign for solar energy systems.	All communication modalities differ on the performative (types and functions of interactions) and on the referential (relations of concepts) level. No differences between the modalities were found regarding group work and satisfaction of the members. Group performance was judged better in face-to-face than in computer-mediated groups.
Fisher et al. (2006)	9 hand-selected Usenet	Newsgroups vary in terms of the populations of participants and

	newsgroups (Jan 2001 or January 2004) from the following genres: question and answer, social support, discussion, and flame.	the roles that they play. Newsgroups can be characterized by populations that include question and answer newsgroups, conversational newsgroups, social support newsgroups, and flame newsgroups.

Table 1: Summary of studies focusing on interactivity and response patterns

When analyzing social interactions in online settings, special characteristics of online communication have to be taken into account. For example, several conversations can go on at the same time resulting in related message not being posted in consecutive order (Greenfield and Subrahmanyam, 2003; Lapadat, 2002; O'Neill and Martin, 2003; Herring, 1999). Herring (1999) found that adjacent messages are often neither related nor relevant to each other. This makes it more difficult for the communicator to follow up the conversation. Herring and Nix (1997) state that this could be a reason for findings that conversations in CMC settings tend to decay from the topic quite quickly. Also, sometimes, several different conversations take place and overlap each other at the same time (Herring, 1999). Thus, interaction in CMC settings is generally much more incoherent when compared to face-to-face interaction (Erickson, 1999). Also, it is quite common in CMC settings that one initial message triggers multiple responses, and also the other way round: one message can refer to multiple other messages. This occurs especially in asynchronous CMC settings where messages are often longer and one message can refer to multiple conversations.

As mentioned above, several studies have been conducted in order to investigate the content and characteristics of responsive and interactive messages. However, these studies have looked at online communities in general, rarely taking into account the target population or the topic of the online community. As Fisher et al. (2006) and Joyce and Kraut (2006) suggest, online communities' responsiveness and interactivity vary largely depending on the topic of the online community as well as its target population. Our study contributes to existing research by focusing on online support communities for older people specifically. We believe that our narrow focus allows for a more detailed investigation of how messages are related and contribute to the sustainability of online support communities for older people.

3. Methodology

3.1 Description of the online support community

To address our study objectives, we analyzed messages from the depression discussion group within SeniorNet (www.seniornet.org), an online support community for older people. SeniorNet started off as a non-profit organization in 1986, founded by Dr. Mary Furlong as part of a research project. SeniorNet aims to teach older people how to use computers and the internet. In order to support their offline activities, SeniorNet established a website which hosts several different discussion groups about various topics. Social interaction is an important characteristic of SeniorNet and former studies about its online community described it as a supporting and caring environment (Ito et al., 2001). SeniorNet includes many discussion boards about various topics. Each discussion board has a moderator, who watches over the discussion and encourages people to take part. At the time of data collection, we retrieved all available messages from the discussion board about depression within SeniorNet, resulting in a total of 961 messages posted over a period of 6 years (August, 2000 until August, 2006) by 78 users. Within this time period, the online community had gone through various levels of activity making it an appropriate online community to study the relationship between conversation pattern and level of activity.

In SeniorNet, messages are presented in timely order without being sorted into threads. This is different to many other online communities, in which messages either open a new thread or are represented within an existing thread as a response to a previous message. The design of the

discussion board about depression within SeniorNet does not give any indication about the relationship of messages other than their content. This was believed to further increase the incoherence of the communication as without a visualization of the communication structure, members do have no indication about how messages are related to each other and how they form a conversation.

3.2 Ethical considerations

As our study involved data gathering from an online support community, we had to consider ethics in internet research, especially regarding the issue of informed consent. Researchers agree that consent is not required for every research project, as the distinction whether the data collected is private or public has a great influence on determining whether consent is required or not (Frankel and Siang, 1999, Eysenbach and Till, 2001). If the setting of data collection is private, informed consent needs to be obtained; however, if the setting is regarded as public, informed consent is not required. King (1996) argues that it is difficult in online settings to distinguish between public and private. Frankel and Siang (1999) claim that the Internet is a public domain and messages posted on the internet are intended for the public. They see the internet as a public space, because the access to online communities is often open and people should know and expect that their messages will be read by a wide audience. The ProjectH Research Group who worked on ethical issues for internet research voted in favor of an ethical policy that does not require researchers to get permissions for collecting and analyzing messages posted in publicly accessible online communities (Paccagnella, 1997).

We decided not to obtain consent from SeniorNet for several reasons. First of all, the discussion boards are publicly available for all internet users and there is no need to register in order to read them. Furthermore, SeniorNet is a well-known organization. The fact that many users know and access it defines it as a public portal. Taking all these into account, we concluded that the members of SeniorNet are aware of the publicity of the discussion boards and therefore this online community can be treated as a public space where research data can be collected without having to achieve informed consent before data collection. Furthermore, our study focuses on the analysis of message-sequences, which are analyzed independently from the person who sent the message. However, to ensure confidentiality and anonymity, the usernames of the members were not revealed in the study and the full quotation of messages was avoided.

The method of our study consists of three distinctive main stages: (1) data preparation in which we coded our data and investigated the level of activity over time, (2) identification of message-sequences (see objective I.), (3) analysis of relationship between the message-sequences and the level of activity within the online support community (see objective II). These stages are described in more detail in the following sections.

3.3 Data preparation

Message coding

In order to analyze the content of the communication within the online community, qualitative content analysis of the messages was undertaken using a coding scheme (see table 2) for communication content in online support communities for older people (Pfeil and Zaphiris, 2007). The coding scheme was developed using the grounded theory approach (Glaser and Strauss, 1967; Strauss and Corbin, 1998). After reading through the messages, we identified keywords and themes that emerged within the communication and which were then sorted into categories. This was an iterative process and we went through the messages several times, and in each cycle our categories were revised. This procedure was repeated until saturation was reached and our set of categories was found to describe the data set appropriately and completely (Pfeil and Zaphiris, 2007). Individual messages were divided into text units that had one coherent meaning and then each text unit was coded into one of the seven categories of the code scheme. As the decision of what constitutes a meaning is very subjective, we

developed a guide for determining the unit of analysis that the researcher followed when segmenting a message into units of analysis. One message can be sorted into one or more categories.

Category	Description	Example
Self disclosure (SD)	Text units in which people post information about themselves. This can be narrative and/or emotional. It can stand independently but it can also be related to an experience that another person has made.	"I yawn all the time. I want to go to bed. I know you're supposed to get out, but I don't have the energy to do that much."
Community building (CB)	Text units in which people post meta-information about communication activities on the discussion board. This can be a comment on one's own activity as well as a comment (often appreciation or thanks) on somebody else's activity(ies) or the online community as a whole.	"Thank God for this board, as I can sit here and cry and rattle on — you are the only ones who understand."
Deep support (DS)	Text units in which people post support that is customized towards the unique situation of the target that the message is for. It shows that the poster understands the situation of the other, and often includes advise or sympathy for this person.	"Words are so hard right now. So I place my hand gently over yours and let love and sweetness flow through to you."
Light support (LS)	Text units in which people post uplifting and encouraging supportive messages that are written in a generic way. This can be targeted towards another person or the whole community.	"Hang in there", "I am thinking about you" "Best wishes"
Factual information (IF)	Text units in which people post factual information. This can include questions and answers about the topic of the online community (e.g. medication for depression).	"So in ''both cases'' situational depression and bipolar depression they alter chemicals in the brain?"
Off topic (OT)	Text units in which people post about other people who are not part of the online community or about topics that strayed away from the theme of the discussion board.	"Sorry to hear Iowa's weather yesterday. Minnesota is much too cold and damp."
Technical issues (TI)	Text units in which people post technical problems or suggestions to solve them.	"Read in your browser screen and have Notepad or Wordpad minimised…"

Table 2: The categories of the code scheme

In order to test for inter-coder reliability, we investigated both the inter-coder reliability of the segmentation of one message into text units with the same meaning and the categorization of the coding scheme. For the segmentation, we established a set of statements that helped the coder to segment the text of a message into text units with the same meaning. Taking a sample of 10 messages, two independent coders agreed on the segmentation in 84% of the cases. The remaining cases were discussed and the rules for segmentation were adapted respectively. In order to test the reliability of the coding, we did an inter-coder reliability check with 5 independent coders in addition to the main researcher. After a short training session, each coder was given a different, random set of 15 messages and was asked to code this data independently. The main researcher also coded all sets of messages and this coding was compared to the coding of the 5 additional independent coders. The mean Cohen's

Kappa for all 5 coder-comparisons was 0.67 (standard deviation: 0.15) ranging from individual code-agreements of 0.51 to 0.93. Based on Stemler (2001) the results of our inter-coder reliability are satisfactory. The coded data was taken as a basis for the analysis of message-sequences in our data-set. After inter-coder reliability was established, the full data-set was segmented and coded by one researcher using MAXqda (2007), a qualitative data analysis tool which facilitates the segmentation and categorization of text. Each message was entered into the software as a distinct text document, and different text units within one message were assigned different codes.

Analysis of level of activity

When investigating the level of activity within online communities, researchers often look at pre-defined time-units (e.g. weeks or month) and investigate the level of activity by comparing them. We decided against such a method, as grouping the number of messages in chunks of weeks or month would force the data into pre- defined groups and might lead to a biased interpretation of the data (e.g. if there is a period of high level of activity that stretches over two half-months, an analysis looking at posts per month would miss this trend). However, when looking at each day individually, we found that there were huge differences between the days and no clear tendency was visible when plotting the level of activity for each day individually (e.g. even in times of high level of activities there were days when no single message was sent). Thus, we decided to calculate a ‘‘running average’’, in which the value for each day is calculated by not only taking into account the number of messages sent on the individual day, but also the number of messages sent on the days prior and after that day. In our case, we calculated a ‘‘31 day running average’’ of the number of messages per day (for a similar approach see Gloor, 2005). This was done for every day in the analyzed period, by averaging the number of messages sent in a time ranging from 15 days before the current day to 15 days after the current day and assigning the average to this date. By doing this, we avoided separating the data into pre-defined time-units (e.g. months) while still having a curve that was smooth enough to identify clear phases of high/low activity. We then plotted the data and this diagram was taken as a basis for identifying periods of increasing, decreasing, high and low activity within the online support community.

3.4 Identification of message-sequences

We investigated two different kinds of message-sequences. Firstly, we were interested in sequences of two consecutive messages irrespectively of whether these two messages refer to each other or not. We analyzed the content of consecutive messages by looking at the categories that the text units within these messages were coded into. As the most recent message is always displayed at the top of the page and is the one that members see when they compose a new message, we expected that the content of the current message is influenced by the content of the message preceding it.

However, as previous research has shown (Herring, 1999), messages that are posted in consecutive order might not reflect accurately the structure of the conversation, as these two messages might not refer to each other. This is especially true for our online support community as the discussion board is not sorted into threads and therefore two messages that refer to each other might not be posted after each other but would be a few messages apart from each other. Also, messages might refer to (or be referred to by) several other messages. Thus, we also investigated the sequences of messages that referred to each other. We judged that two messages referred to each other, when either or both of the following cases were true: (1) a message would refer explicitly to a previous message by addressing it directly or (2) a message would follow up a conversation without explicitly addressing it but by assuming knowledge that could only be gained by reading the previous message. After determining the relations between messages, we analyzed the content of two related messages, taking into account that one message could refer to several other messages and could also be referred to by several messages.

Having message-sequences both for consecutive as well as related messages, we applied event sequence analysis (Bakeman & Gottman, 1997). Using Jeong's (2005) ''Discussion Analysis Tool'', we calculated the frequency of two categories occurring in a message-sequence. A transition probability matrix was calculated that contains the probability that the first category will be followed by the second. Then, Z-scores were calculated based on the overall probabilities of each code pair occurring. A Z-score of 2.32 (equivalent to a significance level of 0.01) has been used to determine whether a sequence of categories occurs significantly more or less often than the random value based on the probability of the individual codes (Jeong, 2005). The results are presented in state transition diagrams that visualize the message-sequences that occur significantly more or less often than random (see figures 1 and 2).

3.5 Relationship to online community lifecycle

In order to find out if and how specific patterns of communication relate to the general activity of the discussion board, we analyzed whether specific message-sequences would occur at specific points in time during the 6 years. We focused on message-sequences that occurred significantly more often than random. In order to link the occurrence of these message-sequences to the general level of activity on the discussion board, the following methods were used:

Interpretation of frequency visualization

We plotted the frequency of messages and the occurrence of the separate message-sequences under investigation per day in separate diagrams (see figure 3). Comparing the visualization allowed us to get an initial indication of the general connection between the level of message frequency and the level of occurrences of the investigated message-sequences.

Correlations

We calculated Pearson's correlation coefficient in order to investigate the relationship between the occurrence of the message-sequences and the general level of activity within the online community. For our data analysis we only used the message-sequences that came up as appearing significantly more often than random in the previous analysis. We then correlated the occurrence of each of these message-sequences with the number of text units posted per day. We also correlated the occurrence of the investigated message-sequences with each other. We then used a standard t-test to check the correlations for significance (see table 3).

4. Results

4.1 Content and evolution of the online community

Over the period of 6 years, 961 messages were posted. These 961 messages were sorted into 2118 different text units (on average 2.2 text units per message). On average, 0.44 messages a day were sent. The message frequency varied greatly in our sample, as it ranged from 11 messages a day to 2.5 month in which no message was posted.

4.2 Message sequence

Figure 1 shows the state transition diagram for consecutive messages as they are occurring in the online community and figure 2 shows the state transition diagram of message-sequences of one message referring to another. An arrow pointing from one code (a) to another code (b) indicates the occurrence of a message-sequence where code (a) is followed by code (b). A dashed line indicates that the observed value of this message-sequence is significantly lower and a continuous line indicates that the observed value is significantly higher than the random value based on the probabilities of the individual codes. To ease interpretation, only those that are significantly different from the random

value are included in the diagrams. Pairs of codes who are not significantly different are not shown in the figures. For example, the solid arrow pointing from *Self disclosure* to *Deep support* in figure 1 indicates that *Self disclosure* is followed by *Deep support* significantly more often than the random value based on the probabilities of the individual codes. In contrast to that, the dashed arrow pointing from *Self disclosure* to *Technical issues* shows that *Self disclosure* is followed by *Technical issues* significantly less often than the random value based on the probabilities of the individual codes. The numbers on the arrows show the transition probabilities from a given code to another. The probabilities of all arrows pointing away from any code would add up to 1 if all transitions were included. For example, in figure 1, the value .15 on the line from *Self disclosure* to *Deep support* shows that 15% of text units coded *Self disclosure* are followed by *Deep support* and the value .02 on the line from *Self disclosure* to *Technical issues* shows that 2% of text units coded *Self disclosure* are followed by *Technical issues*. The remaining 83% of text units coded into *Self disclosure* are followed by the five remaining categories, but in a frequency that is not significantly different from the random value based on the probabilities of the individual codes.

As one can see, the state transition diagram investigating the related messages (see figure 2) shows more distinctive patterns compared to the one analyzing consecutive message patterns. This difference supports Herring's (1999) claim that two consecutive messages within a CMC setting might not automatically relate to each other. Both of these results give valuable insight into conversation patterns within the online support community. The state transition diagram of two consecutive messages (figure 1) gives insight into the influence of the previous message on a current message irrespectively of whether these two messages refer to each other or not. The state transition diagram of related messages (figure 2) shows adjacency pairs of a conversation as they are intended. This will be further addressed in the discussion.

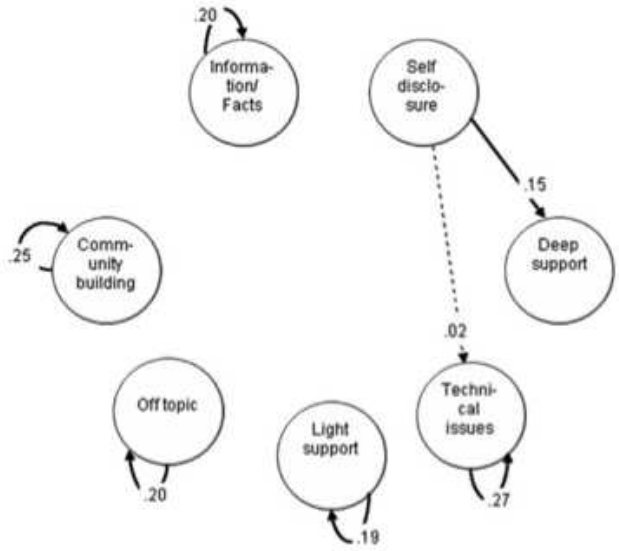

Figure 1: State transition diagram for consecutive messages ($p < 0.01$)

4.3 Relationship to online community lifecycle

In order to relate patterns of message-sequences to the level of activity within the online community, we focus on the pairs of categories that came up as appearing significantly more often than random in related messages (see the pairs connected via solid arrows in figure 2). Namely, these sequences are: *Self disclosure–Self disclosure*, *Self disclosure – Deep support*, *Deep support – Community building, Deep support–Self disclosure, Community building–Community building*, *Light support–Light support*, *Factual Information–Factual Information*, *Off topic–Off topic*, *Technical issues–Technical issues*.

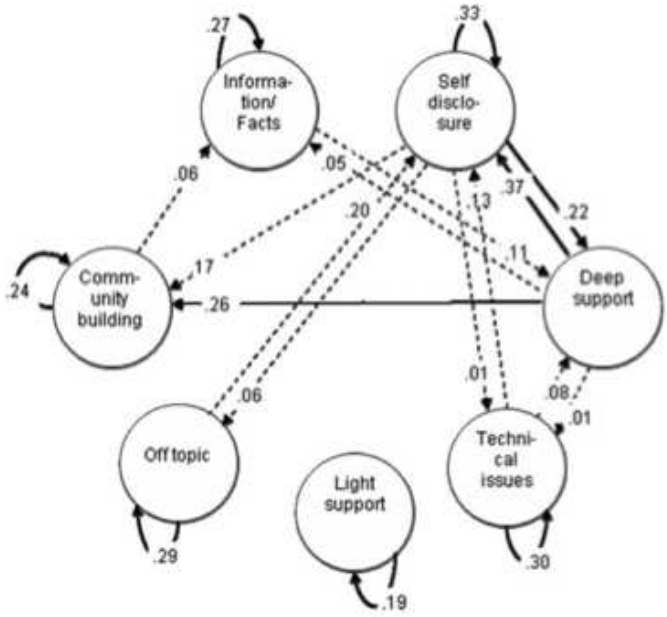

Figure 2: State transition diagram for related messages ($p < 0.01$)

Figure 3 shows the level of activity within the online community (lower part) and the frequency of occurrence of a specific message-sequence for all investigated sequences separately (upper part). The frequency of message-sequences is visualized by the size of circles. The smallest circle represents 1 occurrence of the respective message-sequence at the time the circle is shown. The diameter of each circle scales with the number of occurrences of the sequences. The larger the circle of a message-sequence at a specific time, the more incidences of this message-sequence were posted at that point in time.

In addition, we calculated the correlation of the occurrence of message-sequences and the message frequency in order to investigate the relationship between the message-sequence and the level of activity within the online community. The values are presented in table 3. Our interpretation mainly focuses on the correlation of the message-sequences with the number of text units (bold). In general, a high correlation value indicates that the sequence occurs proportionally to the message frequency (e.g. occurs very often in times of high message frequency and less often in times of low message frequency). A low value indicates that the sequence does not closely follow the level of message frequency. In addition, the occurrences of message-sequences were also correlated with each other and high (above 0.3) and significant values (bold) were used in our interpretation.

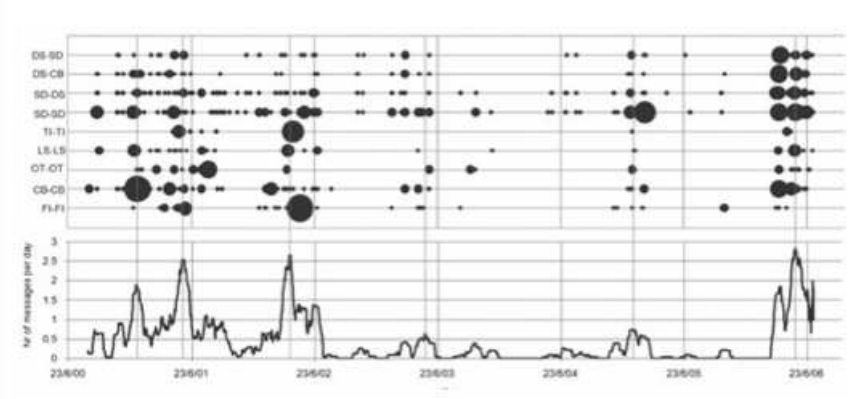

Figure 3: Relationship between the level of activity within the online community and the occurrence of message sequences

	#text units	SD-SD	FI-FI	CB-CB	OT-OT	LS-LS	TI-TI	SD-DS	DS-SD	DS-CB
#text units	–									
SD-SD	**0.51***	–								
FI-FI	0.23*	0.10	–							
CB-CB	**0.47***	0.23*	0.03	–						
OT-OT	0.22*	-0.01	-0.05	0.10	–					
LS-LS	**0.30***	0.19*	-0.03	0.07	0.05	–				
TI-TI	0.14*	-0.03	-0.01	0.07	-0.01	0.05	–			
SD-DS	**0.47***	**0.50***	0.08	0.26*	-0.01	0.16*	-0.08	–		
DS-SD	**0.46***	**0.48***	-0.01	0.17*	-0.01	0.14*	-0.04	**0.38***	–	–
DS-CB	**0.42***	0.28*	0.01	**0.47***	0.06	0.16*	-0.03	**0.33***	**0.38***	–

Table 3: Correlation values (significance level of $p < 0.01$ is indicated with a *)

5. Discussion

For almost all related message-sequences (see figure 2) and most of the consecutive message-sequences (see figure 1), pairs of the same category occur as a sequence. An explanation for this phenomenon in two consecutive messages could be that people tend to imitate the behavior of others. In SeniorNet, the most recent message is shown at the top of the page and people see this message when they post their own message. The fact that two consecutive messages are very likely to contain text units of the same category indicates that people tend to imitate the message that they see on the screen. The design of the online community could thus strengthen the tendency to imitate other members' posting behavior in consecutive messages. However, the fact that this tendency is also true for messages that are related (not necessarily posted in consecutive order) shows that people also tend to answer like messages with like replies irrespectively of what kind of message they see on the screen. Looking at our data set, we could for example see that when people add a paragraph of *Light support* to their messages (e.g.: *''Also, hope all youse guys are doing well and feeling good, too. I hope [name] and [name] will turn the corner and feel better.''*) others tend to imitate this behavior in

their messages and also add a paragraph of *Light support* to their own message (irrespective of the content of the rest of the message and who they are writing to).

The fact that a similar pattern is also found in two text units that are related to each other (not necessarily posted in two consecutive messages) shows that posters also tend to refer to another post by writing content that is of the same category to the one it refers to. This finding could be an indication for rapport building in the online support community and is also in line with previous research that shows that two related messages are likely to be similar (Becker-Beck, 2005; Joyce & Kraut, 2006).

In the following sections, we will discuss the nature and characteristics of each of the sequences of messages that occurred significantly more often than random in our online community and also look at their role in relation to the level of activity within the online community. The discussion is organized according to the message-sequences that were found to occur significantly more often than expected in related message-sequences (see the message-sequences connected via a solid arrow in figure 2). Based on our results, we interpret these message-sequences within the online support community (objective I.) and also discuss their relation to the level of activity within the online community (objective II.).

5.1 Community building — Community building

Our results show (see figure 2) that the sequence *Community building—Community building* occurs significantly more often than random in our data set. The following excerpt shows an example of two related text units that are sorted into the category *Community building*:

Msg 1: *''Today is the first day I have returned to SN, hope to be around a little more, but not as regular as I was. It's good to be able to be here.''* (CB)

Msg 2: *''Hey, hey . . . [NAME]! It's good to see you back, Girl, [. . .]. We'll all be here whenever you can get here. [. . .] Whatever is convenient for you is just fine.''* (CB)

As our example shows, text units that are sorted into the category *Community building* in related messages are often posted in order to reassure each other about the fact that the online support community is a place of togetherness and caring. Thus, it seems that the sequence of *Community building—Community building* is a vital component in building an atmosphere of trust and understanding within the online support community we studied.

The sequence of *Community building—Community building* is among the sequences that correlate high with the number of text units (correlation value .47), indicating that the occurrence of the sequence follows the level of activity within the online community. Looking at figure 3, we can see that this message-sequence seems most prevalent in times when the level of activity is increasing (shortly before the peak). These two results indicate that the sequence of *Community building—Community building* is part of the basic components for communication within the online community and related to the increase of the level of activity.

5.2 Self disclosure—Self disclosure

Our results show that in general, members of the online support community respond to messages containing *Self disclosure* by posting also messages that contain *Self disclosure* (see figure 2). The following messages of related messages give an example for this.

Msg 1: *''My husband, [NAME], passed away [. . .] exactly 3 weeks to the day after being diagnosed with lung cancer. [. . . [I'm so sad that he is not here.[. . .]''* (SD)

Msg 2: *''I understand how you feel. I've been widowed a number of years, now, and it's still*

difficult.'' (SD)

This message-sequence externalizes the commonalities and is thus used to build a sense of commonality and togetherness. It seems that this sequence is posted in order to externalize that they are all in the same situation and build a basis of common experiences. Having experienced a similar situation is vital for the exchange of support, when people know that others have similar experiences, the support exchanged tends to be perceived as better and more trustworthy (Pfeil et al., 2009).

Looking at the relation of this sequence to the level of activity within the online support community, we can see that the sequence *Self disclosure—Self disclosure* shows the highest correlation with the level of activity within the online community (.51; see table 3). In addition, as figure 3 shows, this sequence seems to be constantly present, irrespective of the frequency of messages. These results indicated that text units coded into the category *Self disclosure* are a basic component for the conversation as they occur also in times when the level of activity is generally low. People talk about themselves, mutually opening up towards each other, often discovering that they have a lot in common. This is then used as the basis for further conversation to happen.

5.3 Self disclosure and Deep support

Both state transition diagrams (figure 1 and 2) show that text units that are coded into the categories *Self disclosure* are also often followed up by text units coded into the category *Deep support*. Thus, posters often talk about their problems that trigger postings by others who want to help this person, containing text units that are coded into the category *Deep support*. The following example illustrates such a message sequence:

Msg 1: "*It's been a bad day today, I can't stop crying & I feel so sick & panicky. I thought I could fight this off but it looks as though I'll have to go to the doc. next week.[. . .]*" (SD)

Msg 2: "*[name]—This is such a hard loss to go through. I send you longdistance hugs. Crying is so good for you. And it is also a good idea to see your doctor. Just for a check-up. [. . .]*" (DS)

However, as figure 2 shows for related messages this connection is also very strong in the opposite with *Self disclosure* following *Deep support*. Looking at these instances in our data set, we found that the exchange of *Deep support* and *Self disclosure* is often a process that exceeds the sequence of two messages. This is also supported by the high correlation of message-sequences coded *Self disclosure—Deep support* and *Deep support—Self disclosure* (.38). Often, this kind of conversation is initiated by a message containing self-disclosing text which is then followed up by text coded into the category *Deep support*. But the conversation does not stop here, as people tend to refer back to the supportive message, often by giving an update about their new situation. Also, sequences that include text units coded into the categories *Self disclosure* and *Deep support* seem to be fairly disconnected to all other categories (see dashed arrows in figure 2).

Investigating the relation between the sequence *Self disclosure — Deep support* and the level of activity within the online community, a quite high correlation value (.47) indicates that the occurrence of the sequence follows the level of activity within the online community. The same is also true for the sequence *Deep support—Self disclosure* (correlation value with the level of activity: .46). This tendency is similar to the sequences *Self disclosure—Self disclosure* and *Community building—Community building*. As figure 3 shows, the sequences *Self disclosure—Deep support* and *Deep support—Self disclosure* occur in times of low, as well as medium and high level of activity, suggesting that these sequences are a fundamental part of the communication activity within the online support community. The closeness to the pattern of *Self disclosure—Self disclosure* (see figure 3) indicates that the sequences *Self disclosure—Deep support* and *Deep support—Self disclosure* are follow ups to the previous pattern, suggesting that the exchange of *Self disclosure* and *Deep support* is

the next step of a basic conversation within the online support community, attached to the initial exchange of *Self disclosure*. This is also supported by a high correlation between *Self disclosure—Self disclosure* with *Self disclosure—Deep support* (.50) and *Deep support — Self disclosure* (.48). The correlation values show that these three sequences have a very similar pattern of occurring. Thus, it seems that at the beginning of a conversation, *Self disclosure* is exchanged mutually in order to establish common ground. Once this is successfully done, members start to provide each other with *Deep support* as a follow up to *Self disclosure*. After support is given, members tend to refer back to the conversation by providing an update to the situation and thus answer the *Deep support* with further *Self disclosure*.

5.4 Community building and Deep support

As figure 2 shows, text units that are coded into the category *Community building* tend often to refer to messages containing text units coded into the category *Deep support*. In contrast to that, text units coded into the category *Community building* are very unlikely to refer to messages containing text units coded into the category *Self disclosure*. Investigating the occurrences of the sequence *Deep support—Community building* in related messages from our data-set, we found that community building text units often refer to messages containing text units coded into the category *Deep support* in order to comment on the kind of support given, as the example illustrates:

Msg 1: "*Look for a local support group, get involved […]. This and friends are great for whipping depression. Don't forget medication. If one doesn't work, try, try again.*" (DS)

Msg 2: "*[Your advice] is a good place to start to ''help yourself'' and Senior Net is a safe place to share whatever is troublesome to [us].*" (CB)

Also, sometimes people that received the deep support tend to reply and voice their gratitude.

Msg 1: "*Do try to remember that natural sunshine is an EXCELLENT source of Vitamin D!!! Try to spend at least 20 minutes in the sun each and every day. Don't get sunburned, of course, but it's very good both for your body and your moods.*" (DS)

Msg 2: "*Thanks for that suggestion about the sunshine. People are SO NICE in this discussion! So caring and understanding. Thanks [. . .] for your kindness and interest.*" (CB)

Looking at the relation between the sequence *Deep support—Community building* and the level of activity within the online community, our results show that the occurrence of this sequence is quite highly correlated with the level of activity (.42), indicating that the sequence is a basic component of communication within the online community. Also, our results show a high correlation of the sequence *Deep support—Community building* with the sequences *Community building—Community building* (.47), *Self disclosure—Deep support* (.33) and *Deep support—Self disclosure* (.38) and a moderate correlation with the sequence *Self disclosure—Self disclosure* (.28). This result together with findings discussed in previous sections, suggests that the sequence *Deep support—Community building* might be part of a conversation structure consisting of a series of sequences: After establishing common ground (message sequence *Self disclosure—Self disclosure*) and giving initial support as a response to self disclosure (*Self disclosure—Deep support*), community building messages tend to be added (*Deep support—Community building*) in order to reflect on the activity and support given, often resulting in positive statements about the activity within the online community. As the high correlation between the sequence *Deep support—Community building* and the sequence *Community building—Community building* (.47) indicates, the sequence *Community building—Community building* might be the last of a series of sequences within the online community that constitute the basic conversation pattern within the online community. However, the sequence

Community building—Community building seems to also be slightly detached from the self disclosing and supportive communication as the moderate significant correlations with the sequences *Self disclosure — Self disclosure* (.23) and *Self disclosure — Deep support* (.26) and a low correlation with the sequence *Deep support—Self disclosure* (.17) show.

5.5 Light support—Light support

As figure 2 shows, the mutual exchange of text units coded into the category *Light support* also occurs very often in our data set. This sequence only shows a moderate correlation (.30) with the number of text units, indicating that the occurrence of the sequence does not closely follow the level of activity. Looking at figure 3, we can see that the message-sequence of *Light support—Light support* is hardly found in periods of low and medium activity and is prevalent only in times of high message frequency indicating that a certain level of activity is necessary in order to engage in mutual exchange of this kind of support. Light support consists of the exchange of general, uplifting comments (e.g: *"Good luck and blessings to you both"*). The fact that light support is only exchanged in times of high message frequency suggests that this message-sequence is not part of the basic conversation within the online community. This claim is further strengthened by the fact that the sequence *Light support—Light support* shows significant but low correlations with the sequences of basic conversation, namely *Self disclosure — Self disclosure* (.19), *Self disclosure — Deep support* (.16), *Deep support—Self disclosure* (.14), and *Deep support—Community building* (.16).

5.6 Factual information — Factual information

Our results show that a sequence of two related text units categorized into *Factual information* is also prevalent in our data set. As our next example shows, this sequence often consists of a question and an answer:

Msg 1: "*My one question to [name] and [name] is what is the difference between chemical depression, since I am BiPolar, and situational depression*." (FI)

Msg 2: "*Depression can be triggered by an event. Once the depression sets in, the chemicals in the brainactuallyalter.[...]*." (FI)

The sequence shows only a very low correlation value with the number of text units (.22) indicating that it occurs fairly independent from the level of activity within the online community. Also, as figure 3 shows, the message-sequence of *Factual information–Factual information* occurs very concentrated, as it either doesn't occur at all, or it occurs extensively at once. People exchange text units categorized into *Factual information* independently of the level of activity within the online support community, often resulting in the exchange of even more message-sequences of this kind, before it drops and this sequence does not occur anymore for quite a while.

The fact that the sequence of *Factual Information—Factual information* is neither equally distributed nor highly correlated with the level of activity suggests that the exchange of *Factual information* is not part of the communication contributing to the sustainability of the online support community. This is also supported by the very low correlation of this sequence and the sequences of *Self disclosure—Self disclosure* (.10), *Self disclosure—Deep support* (.08), *Deep support—Community building* (.01) and *Community building—Community building* (.03).

5.7 Off topic — Off topic

As figure 2 shows, a text unit coded into the category *Off topic* is often related to another *Off topic* text unit. Sometimes a thread of conversation drifts away from the actual topic of the discussion, resulting in a sequence of *Off topic* text units, like the following example:

Msg 1: "*It's still wintertime here . . . lots of snow around and temps still in the 30s . . . may get into 40s this weekend which will seem WARM!*" (OT)

Msg 2: "*I am sick of this weather, too . . . Tomorrow we get yet another storm here on the rocky coast of Maine . . . I quess that I am just going to have to lite a candle to the Spring Fairy!*" (OT)

A moderate correlation value between the sequence *Off topic–Off topic* and the number of text units (.22) show that this sequence does not closely follow the level of activity within the online community. Looking for more details in figure 3, we can see that the sequence occurs mostly when the level of activity is decreasing or when the level of activity is medium. Also, the sequence *Off topic–Off topic* does not often occur in times when the level of the mutual *Self disclosure*-, *Deep support*- and *Community building*-sequences is high as very low correlation values between the sequence *Off topic—Off topic* and the sequences *Self disclosure—Self disclosure* (−.01), *Self disclosure—Deep support* (−.01), *Deep support—Community building* (.06) and *Community building—Community building* (.10) show. Mutual *Off topic* sequences occur mainly when the level of activity is decreasing which might be at times when no serious emotional and supportive message exchange takes place. This suggests that this message-sequence is related to a decrease in activity within the online community and thus might have a negative influence on its sustainability.

5.8 Technical issues — Technical issues

As figure 2 shows, text units coded into the category *Technical issues* are often followed by text units coded into *Technical issues* as well. Like the sequence of *Factual information—Factual information*, the sequence *Technical issues—Technical issues* often consists of question-answer sequences concerning technical problems and tips on how to use the online community.

Analyzing the relation between the sequence *Technical issues—Technical issues* and the level of activity within the online community, a very low correlation value (.14) indicates that the sequence is not related to the level of activity within the online community. Looking at figure 3, we can see that - like the message-sequence of *Light support–Light support* - the message-sequence of *Technical issues–Technical issues* only occurs in times of high message-frequency. Also, it seems like there are either a lot of *Technical issues — Technical issues* sequences at once or none at all. This finding suggests that the exchange of text units coded into the category *Technical issues* is not part of the basic conversation structure within the online community, as it never occurs in times of low or medium message exchange. Similar to the mutual exchange of *Light support*, members post sequences of *Technical issues–Technical issues* only when there is already a basis of other conversations going on at the same time. Text units coded into the category *Technical issues* are focused on getting help on how to post or how to use the discussion board. A regular participation and enough conversation about other things is the basis for this exchange to happen.

6. Conclusion

This study has shown that specific message-sequences have specific roles in the communication within our online support community. By extracting these sequences, we identified important components of conversation within the online community (objective I.). Furthermore, our findings showed that different kinds of message-sequences occur only at times when the online community has a specific level of activity (objective II.).

We believe that our findings are of significance in several ways. First, our findings contribute to the frequently discussed topic of how successful online support communities are. The characteristics of the message-sequences and their relation to the level of activity within the online community as discussed in this paper help us to see what makes a successful and popular community. Secondly, we

identified the role of message-sequences for the sustainability of the investigated online community for older people. By revealing the various characteristics of conversation, we investigated in depth the components that are necessary to nurture an online support community. We conclude that the basic conversation within the online support community consists of an initial mutual exchange of self disclosing messages in order to build a common ground among members of the online community. Once this is achieved, it seems that the basis is laid for answering self disclosing messages with text units coded into the category *Deep support*. The exchange of *Self disclosure* and *Deep support* can go on for a while, but often *Deep support* is also often followed up with text units coded into the category *Community building* in order to appreciate the support given. This sequence of *Self disclosure—Deep support—(Self disclosure—Deep support)—Community building* was found to be the basis of communication within the online support community as it would occur equally in all stages of the evolution of the online community, and would also often start a conversation after a quiet period. In addition, we also identified message-sequences that only occur when the level of activity within the online community is high (*Light support—Light support* and *Technical issues—Technical issues*), indicating that these message-sequences are only occurring when there is enough other communication going on at the same time. The exchange of factual information, however, showed a clearly different relationship to the level of activity within the online community, as it seems to be independent of the level of activity within the online community and is exchanged when needed. The message-sequence *Off topic—Off topic* was found to be related to a decreasing activity-level within the online community as it only occurred at times of relatively low message frequency and at times when the message frequency is decreasing.

Our findings contribute significantly to the analysis and evaluation of online communities. By knowing the characteristics of important message-sequences and how they are related to the level of activity within the online support community, we are able to spot the roots of existing problems or successes. This knowledge could also help moderators of online support communities to maintain and nurture an online support community, making them more successful and thus also more beneficial.

Our analysis focuses on online support community for older people and we believe that our findings provide specific insights into communication patterns for this target group. As we did not do a comparative study with online support communities for other target groups or online communities in general, it is difficult to gauge to what extent our findings are generalizable. We know from previous research that older people have special needs when participating in online communities (Pfeil et al., 2009) and tend to have different communication patterns from other target populations (Zaphiris & Sarwar, 2006). Thus, we argue that our findings are specific for older people and distinct from other online communities for different target groups. However, further research is necessary in order to clarify the nature of this difference. Thus, we encourage others to apply our categories and methods to other online communities in order to allow for a more robust comparison. Also, our findings suggest that there might be message-sequences which go beyond a pair of codes, but actually consist of a series of three or more codes or form a cluster or clique of several messages. Further analysis will be necessary in order to investigate patterns of messages that go beyond a message-sequence.

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