

The Known Stranger: Supporting Conversations between Strangers with Personalized Topic Suggestions

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ABSTRACT

Striking up a good conversation with new acquaintances is often difficult. In this paper we introduce a system that uses a ranking recommendation algorithm to generate real-time personalized topic suggestions during a conversation. The system then delivers the suggestions via Google Glass. We conducted a study with 38 pairs of strangers, who received such suggestions while conversing with a person they met for the first time. Participants found the suggestions to be helpful, but only at the right moments, and for certain types of speakers. Our results contribute to the understanding of how communication interventions influence people's experience and behaviors, and enhance interpersonal interactions. Our study also presents design implications for applications on wearable devices to facilitate conversations between strangers.

Author Keywords

Conversations, strangers, personalization, topic suggestion

ACM Classification Keywords

H.4.3. Information systems applications: Communication Applications

INTRODUCTION

Meeting new people and making new friends is an important part of everyday life. Pleasant interaction with friends helps relieve stress and reduce feelings of loneliness [27]. Casual acquaintances or weak social ties can provide resources for various tasks such as job hunting, information searching, or expanding one's social network [8]. The first conversation with a new acquaintance is crucial for the establishment of a relationship [21]. However, maintaining a good first conversation with a stranger after the ice-breaking phase is often difficult.

Various studies have investigated how technologies could improve social interactions between strangers or casual acquaintances. Social games such as FishPong [30] or

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Table Tilt [17] are expected to encourage spontaneous social interaction among coffeehouse patrons and academic conference attendees. These games, however, were not designed to enhance the conversational experience beyond the ice-breaking phase. McCathy [11] introduced a system that displayed suggestions for conversation when two coworkers approached the system.

In this study, we introduced a new technique to help strangers have engaging first conversations. Strangers who share little common knowledge about each other often have difficulties finding good topics for discussion [22]. Our goal was to explore if unobtrusively providing personalized suggestions to collocutors about what to discuss in their first conversation will improve their experience.

Towards this goal, we conducted a study with 38 pairs of strangers where a background system delivers potential conversation topics of mutual interest to the participants during a face-to-face conversation. The system collects preferred topics of discussion from participants a priori and uses techniques in recommender systems to determine a list of conversation topics that would be of interest to both parties. We studied how often participants used the suggestions, how the suggestion impacted the nature of the conversation and how participants perceived the quality of the conversation compared to having no suggestions. We found that suggestions improved conversation experience but only when delivered at the right time. Our results contribute to the understanding of how communication interventions and wearable technologies can enhance interpersonal interactions, and has design implications for systems to facilitate conversations between strangers.

RELATED WORK

How strangers converse

Previous studies have analyzed how two strangers develop conversational topics during the first encounter. Initiating conversation with a stranger involves taking certain risks. Speakers do not want to appear impolite, offensive, or intrusive [22]. Therefore, they tend to start with neutral, non-threatening, safe topics such as the weather, or topics derived from known common contexts [22, 7]. These "setting topics" [22, p. 240] however can only serve as a transition step to deeper, extended conversations. They do not contribute much to familiarity, and are often quickly exhausted, or abandoned [22].

Successful transition steps with the “setting topics” enables strangers to escalate from exchanging non-intimate content (e.g. name, job, hometown, etc.) to highly intimate information on a broader range of topics (e.g. romantic relationships, sexual orientation, etc.), which Svennevig called “encyclopedic topics” [22, p. 240]. Such extended self-disclosure is the key to relationship development [1]. Various studies demonstrated that disclosure of personally relevant information, thoughts and feelings facilitates understanding, increase liking, and invite reciprocation between conversation partners [1]. But if the transition steps are not successful, the conversation becomes non-rewarding and relationships cannot develop further.

During the transition from “setting topics” to “encyclopedic topics”, speakers use the personal information they obtain about each other to compute which topics are rewarding and which are not [22]. For two strangers in their first meeting, finding rewarding topics is difficult [22]. One reason for such difficulty is the lack of information about the partners’ topic preferences [22]. Various studies suggest that common ground, which is the shared knowledge between two speakers, is important for maintaining the content and flow of a conversation [4]. Clark et al. [5] stated that two people could not even begin to coordinate on the content of their conversation without assuming some common ground between them. Yuan et al. [31] found that lack of common ground was among the factors preventing non-native English speakers at an American institution from engaging in informal conversations with native English speakers. Without knowledge about the partners’ interests, speakers cannot predict the partners’ reactions to different topics in order to choose what to say or ask [7, 8]. On the other hand, speakers may not have a good response to, or lack knowledge and interest to follow a topic that the partners suggest [22]. The lack of relationship between strangers prevents them from too much self-disclosure, thus shortening their engagement on certain topics [7, 22].

Facilitating conversation between strangers

Social games like FishPong [30] and Table Tilt [17] aim to encourage spontaneous interaction with strangers at coffee shops or conferences. However, these systems are not designed to influence the conversations content. McCathy developed GroupCast [11], a display in public areas to support conversations among people who passed by it by showing their mutual interests. However, suggestions from GroupCast might not be personalized to the preferences of each speaker. Furthermore, how suggestions affect the conversations between strangers was not evaluated.

We extend previous work to support conversation between strangers by providing suggestions that are personalized at both the individual level and pair level. To go beyond the ‘setting topics’, we collected information about the speaker’s interests, expertise, hobbies, and other personal details with their consent, and applied recommendation techniques to extract their preferences for conversation

topics, and generate suggestions that they are most likely to use.

Developing topics for conversations

To foster rewarding first conversations beyond the initial ice-breaking phase, strangers need information about each other’s interests and preferences for “encyclopedic topics”. Svennevig proposed that knowing areas of common expertise or interest may have strong affiliative effects, as it helps speakers establish extended common ground, and contributes to emotional bonding through common involvement in the discussion [22]. In this study we design a way to help strangers know about each other’s interests to find engaging conversation topics.

Rhodes [19] proposed a system design called *Remembrance Agent*, which retrieved relevant information and delivered it to users. Our system design is similar to *Remembrance Agent*, except we use recommender systems techniques to generate a list of recommendations for a pair of strangers.

Recommender systems research shows that understanding user interests and providing viable suggestions successfully assists users in their daily tasks. These tasks range from individual level tasks (such as finding articles to read [18] or movies to watch [25]) to group level ones, such as forming a community of the same interests or building relationships on Twitter [9]). Public digital information, made available today by various online networking services, can be harnessed to extract user interests and preferences implicitly. For example, Hannon et al. [9] used tweets to infer user preferences, and subsequently were able to recommend other users they should follow. User interests and preferences can also be extracted explicitly. Nguyen et al. [13] showed that enhanced rating interfaces could improve suggestion quality. Using techniques found in recommendation system research, we generate a list of viable suggestions tuned to the preferences of both speakers (as a pair) to support first conversations.

THE CURRENT STUDY

To understand how topic suggestions during a first conversation between two strangers may help improve the strangers’ communication experience, we conducted a study examining the following three research questions:

RQ1. How useful do strangers talking to each other for the first time perceive the topic suggestions to be?

RQ2. How do suggestions affect the conversational experience (regardless of whether participants use the suggestions)?

RQ3: How do participants use the suggestions they receive? Does the number of suggestions used impact the conversation experiences between these participants?

Conversation experience was measured in terms of self-reported ‘liking’ of the conversation, number of silences during the conversation, perceived quality of the conversation and feeling of closeness and connection with

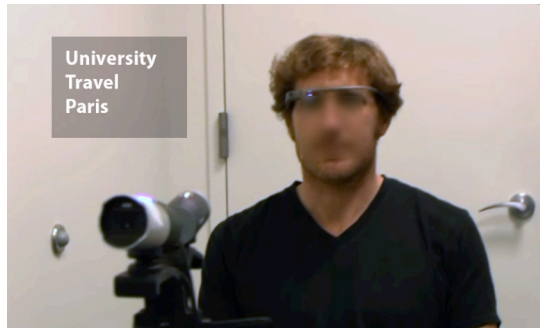


Figure 1. A participant saw at most three suggestions via the Google Glass screen

their partner at the end of the conversation. We expect that the personalized suggestions for each participant and each pair will have positive effects on their conversations.

METHOD

We conducted a lab experiment with 38 pairs of strangers. The manipulation is the presence (or lack thereof) of topic suggestions. Each pair conversed for a total of 30 minutes, divided into two 15-minute conversation sessions. During one of the two 15-minute sessions, both participants in the pair received topic suggestions. In the other session, neither of the participants received suggestions. The order in which participants received suggestions was counterbalanced. 20 pairs received suggestions in the first session, 18 pairs received suggestions in the second session. When suggestions were delivered, participants were told that it was up to them to use the suggestions as conversation topics or ignore if not useful or desired.

Participants

41¹ pairs of English speaking participants (55 males, 31 females, aged 15 to 58, average age 27) who did not know each other were recruited for the study using a corporate recruiting service and word of mouth.

Materials

Website to collect information about participants

A pilot study with 4 participants showed that when talking to strangers, people tend to talk about six areas: 1) their interests and hobbies, 2) jobs, 3) schools, 4) skills, 5) spoken languages, and 6) cities they visited or wished to visit. Prior to the experiment, we built a website to collect² public data regarding jobs, schools, skills, languages, which are available in their LinkedIn profile. Participants were also asked to fill out a personal information questionnaire about their hobbies, favorite cities and personalities.

Algorithm to generate suggestions

We built a ranking recommendation algorithm to generate personalized suggestions that would be of mutual interests to both participants, or of the interests of each participant in

the pair. Thus, the suggestions that were ranked highest were shown first.

First, based on the information we collected about each participant from the website, we generated a list of words or phrases as topic suggestions. We then classified the suggestions into the six aforementioned areas. For each pair of participants, based on how comfortable both participants were with each area of conversation topics, we computed a score representing how likely the pair would use each suggestion. If a suggestion is common to both participants (e.g., a mutual interest or hobby), then this score is the product of the topic preference scores of both participants. Otherwise, we performed a greedy search using Stanford's NLP library [10] and the WordNet Similarity³ with WUP [28] semantic relatedness score to find the topics of conversation both participants wanted to discuss⁴. The score is then computed as the product of the value returned by the greedy search and the topic preference scores. Suggestions with zeros score are discarded. Finally, we manually checked the list of suggestions for each pair and removed all meaningless suggestions (such as stop words).

Delivering suggestions

To avoid interfering with the natural interactions between participants, suggestions are delivered as subtly as possible. Prior research has suggested that dyads in face-to-face conversations are able to process information subtly if delivered visually around the direction of eye gaze [15]. Thus, we used Google Glass to deliver suggestions while keeping the interference with natural eye contact to a minimum. Moreover, the Google Glass screen is only viewable by the participant wearing it. Thus we could avoid revealing the occurrence or content of suggestions to their partners. Participants could also discretely ignore or take suggestions. Figure 1 shows how the suggestions appear on Google Glass screen from the point of view of the participant wearing it.



Figure 2. Participants wore Google Glasses with some suggestions on the screen.

¹ 3 pairs were removed from the analyses due to technical problems

² with participant consent

³ <http://wn-similarity.sourceforge.net/>

⁴ We also implemented an overwritten mechanism in case we found a pair of words has higher semantic meaning than the WUP relatedness score.

Previous work [15] has shown that users are able to maintain continuity of conversations while simultaneously looking at three short phrases on a screen and while listening (not talking) to their conversation partner. Based on this, the system delivers at most three suggestions at a time, every two and a half minutes on average. Participants did not receive suggestions at the same time, and did not receive the same set of suggestions. For most pairs, we allowed approximately equal time between any two subsequent sets of suggestions. Additionally, whenever a participant seemed to be distracted, bored or out of topics for the conversation, s/he also received suggestions.

In summary, the system consists of a recommendation algorithm to pre-compute topic suggestions, a database to store the suggestions, and an interface for the experimenter to deliver the suggestions to the Google Glass.

Communication task

Participants were asked to talk to their partners about anything they wanted except topics related to the current study, such as the lab location or equipment. They were also asked to not tell their partners when they receive suggestions.

Post conversation questionnaire

A paper-and-pencil post-conversation questionnaire was presented right after each conversation session to measure participants' experience during the session.

Procedure

Two participants were randomly paired up and invited to a lab experiment. The experimenter ensured that they did not know each other. Participants were asked to sit facing each other, wearing Google Glasses (Figure 2), and were instructed not to chat before the experiment started.

The experiment consisted of two conversation sessions, during only one of which they received topic suggestions. The second sessions represented what we intended to be conversations between strangers after the initial ice-breaking phase. Each conversation session lasted 15 minutes and was followed by the post conversation questionnaire. Participants wore the Glasses throughout the study. The entire experiment was video recorded. After the experiment, participants were thanked and rewarded.

Measures

Participant's personality

In the personal information questionnaire, participants answered a 10-item Big-Five personality survey measuring extraversion, emotional stability, agreeableness, conscientiousness, and openness to new experience from

Gosling et al. [6]. Following Gosling et al. [6] we average participants' answers to get the measurement for each of these 5 personalities. For easy interpretation of the results, we reverse-coded the items measuring extraversion, and averaged these items to get the measurement for introversion.

Measure	Items
Conversation Quality Cronbach's $\alpha = .78$	I enjoyed the conversation with my partner.
	The conversation was interesting.
	I was able to express my opinions.
	Finding topics of mutual interest was easy.
Closeness to the partner Cronbach's $\alpha = .70$	I want to talk with my partner again.
	I was emotional in the conversation.
	During the conversation, I connected with my partner easily.
Privacy concern	The conversation I just had was intimate.
	I am concerned about my privacy (regarding the information the system collects about me).
Knowledge of partner	I feel that know my partner as a person
Suggestion usefulness	I think the suggestions were useful
Liking of session	I like this conversation session.

Table 1. Survey items to measure participants' thoughts and feelings during conversations

Use of suggestions in each conversation session

During the conversation session in which suggestions were shown, the experimenter marked delivered suggestions that were used by participants in the conversation afterwards. We then calculated the percentage of suggestions that were adopted by the participants.

For pairs where suggestions were displayed during the first session, we counted any topics mentioned during the second session that are related to the suggestions showed during the first session. E.g., if we showed the word "eating" during the first session, and participant discussed different dining places and food during the second session, this was considered to be a valid use of a given suggestion.

Counts of silences

Following McLaughlin et al. [12] a silence in a conversation was defined to be a noticeable pause in the conversation, often after concluding an ongoing topic, accompanied by filler words such as 'umm' or 'uh', and usually followed by a new topic. The researchers listened to audio recordings of the conversations to count the silences.

Self-reported reactions towards the conversation sessions

The post conversation questionnaire consisted of 12 questions used to measure participants' subjective thoughts and feelings towards the conversation. We asked 5 questions to measure general conversation quality [3], 3 questions measuring feelings of closeness towards the partner [3], 1 question on knowledge of the partner, 1 question about liking of the session, 1 question about perceived suggestion usefulness. As privacy concern is one of the main difficulties in implementing ubiquitous computing devices (Rhodes et al [20]), we ask 1 question about their privacy concern. All questions (Table 1) used a scale of 1 (Strongly Disagree) to 7 (Strongly Agree).

RESULTS

We report the results in three main parts according to our three research questions. Table 3 provides a summary of our main findings.

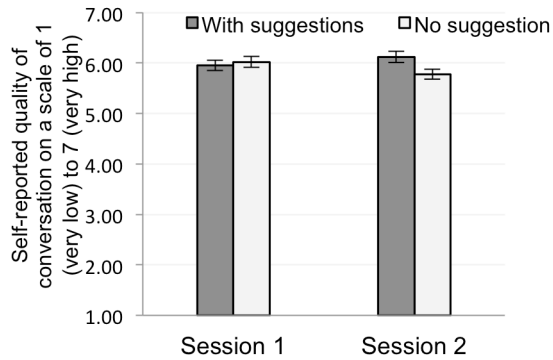


Figure 3. Participants' reported quality of conversation in two conditions, during the 1st and 2nd sessions.

RQ1: Perceived usefulness of the suggestions

First, to answer RQ1, we analyzed how useful the participants found the suggestions delivered to them. The mean rating of perceived usefulness of the suggestions was 4.68 (N = 76, SD = 1.52). A one sample t-test showed that this mean rating was significantly higher than the middle neutral point of 4 ($t[75] = 3.91, p < .001$), suggesting that participants found the suggestions to be somewhat useful.

Furthermore, the mean rating of perceived privacy concern regarding the information our system collected to generate the suggestions was 2.76 (N = 76, SD = 1.77). A one sample t-test showed that this mean rating was significantly smaller than the middle point of 4 ($t[75] = -6.08, p < .001$). So participants were not concerned about the information we collected from them for the study.

RQ2: Effects of suggestions on conversational experience

RQ2 asked how the participants' conversation experience differed if they received suggestions and if they did not. To answer this question, we compared the self-reported reaction towards the conversation sessions where participants received suggestions, and conversation session where they did not. We also compared the number of silences that we counted during each session where pairs received suggestions, and where they did not. We conducted mixed-effect ANOVAs on the self-reported liking of the session, perceived conversation quality, closeness and connection with partner during the two sessions, with suggestion conditions, the session order, and the interaction of the two as the fixed factor, and pairs and participants nested in pairs as the random factor.

Liking of the session. We did not find any significant main effect of suggestions ($F[1, 74]=.14, n.s.$) or session order ($F[1,36]=2.34, p=.23$). We also did not find any significant interaction effect ($F[1, 74]=2.22, p=.14$).

Perceived conversation quality. We found no significant main effect of either suggestions ($F[1, 74]=.26, n.s.$) or session order ($F[1, 36]=2.20, p=.14$), but a significant

interaction effect of session order and suggestion condition ($F[1, 74] = 4.42, p=.03$). This means that the effect of suggestions on perceived conversation quality in the first session was different from the second session.

Hence, we analyzed the data in the first session separately from the data in the second session. We conducted mixed effect linear regressions on the participants' self-reported liking of the conversation during the first session. We included in these mixed-effect regressions the random effect of the pairs. The fixed effects are the suggestion condition (with or without suggestion), the participants' personalities, and their interaction. There was no significant difference in conversation quality between those sessions with suggestions, and those without ($F [1, 36] < 1, n.s.$). With data from the second session, to account for the effects of the participants' feelings during the first session, we added the fixed effects of perceived conversation quality, closeness, and knowledge of partners during the first session. Participants reported significantly higher conversation quality when they received suggestions ($M = 6.12, SE = .08$) than when they did not ($M = 5.78, SE = .08, F [1, 35.96] = 6.76, p = .01$) (Figure 3).

For only the second session, we also found a significant interaction effect of suggestion condition and participants' introversion on the reported conversation quality (N= 76, β [with suggestion] = $-.01, SE = .01, 95\% CI [-.03, .009], F [1, 62.5] = 5.88, p = .01$). We also found a negative main effect of introversion on the reported quality of conversation ($\beta = -.08, SE = .04, 95\% CI [-.15, -.002], F [1, 62.5] = 5.88, p = .01$). Figure 4 shows the relationships between introversion and self-reported conversation quality in two conditions: when participants received suggestions, and when they did not during the second session. When participants did not receive suggestions during the second session, the more introverted the participants, the lower the reported conversation quality. When they received suggestions, however, the reverse relationship emerged: the more introverted the participants, the higher the reported conversation quality.

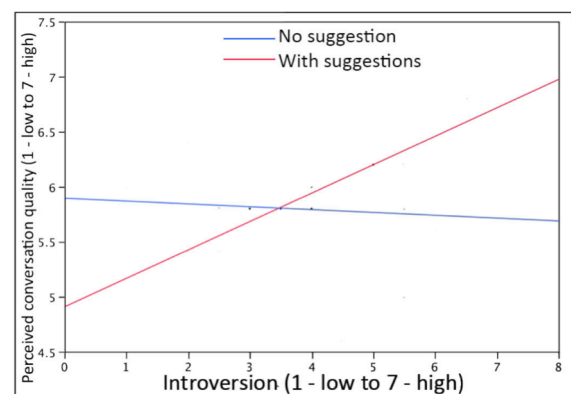


Figure 4. Relationship between self-reported conversation quality and introversion in two conditions in the 2nd session.

Perceived closeness with partner. We did not find any significant main effect of suggestions ($F[1, 74]=1.24, p=.45$) or session order ($F[1, 36]=1.64, p=.21$). But the interaction effect of suggestion and session order was significant ($F [1, 74]=19.49, p<.001$). This means suggestions had different effects on perceived closeness to partner in the first session and in the second session.

During the first session, there was no significant difference in perceived closeness for participants who received suggestions and for those who did not ($F [1, 36] < 1, n.s.$). However, during the second session, participants reported significantly higher closeness if they received suggestions ($M = 4.76, SE = .15$) than if they did not ($M = 3.67, SE = .15, F [1, 37.86] = 23.72, p < .01$) (Figure 5).

Knowledge about partner. We found a significant main effect of suggestion condition ($F[1, 74]=16.85, p<.001$), and a significant interaction effect of suggestion condition and session order ($F [1, 74]= 29.75, p<.001$). The main effect of feed order was not significant ($F[1, 36]=1.23, p=.45$). This also means that the effect of suggestions on self-reported knowledge about the partner differed from the first session to the second one.

During the first session, there was no significant effect of condition on the perceived knowledge about the partners ($F [1, 36] = 2.82, p = .10$). However, the effect of condition was significant during the second session ($F [1, 37.5] = 21.98, p < .01$). Participants reported knowing their partners more if they received suggestions ($M = 6.11, SE = .16$) than if they did not ($M = 5.30, SE = .15$) (Figure 6).

Number of silences. The number of silences for each pair in each 15-minute conversation session was negatively skewed and zero-inflated, with mean 1.053 ($N=76, SD = 1.83, Min = 0, Median = 0, 90th\ percentile = 3, Max = 11$). We conducted a mixed-effect general linear regression for Poisson distributions on the number of silences counted for each pair during each session, with the suggestion condition as the fixed effect, and the pair as the random effect. For the first session, we found that there were significantly more silences if participants received suggestions ($M = 2.10, SD$

$= 2.78, Min = 0, Median = 1, 90th\ percentile = 5.10, Max = 11$) than if they didn't ($M = .50, SD = .85, Min = 0, Median = 0, 90th\ percentile = 1.30, Max = 3, \beta [suggestion\ condition] = 1.28, SE = .53, 95\% CI [.37, 1.75], z = 2.39, p = .01$). For the second session, there was no difference in the number of silences between the suggestion condition and the no suggestion condition ($z = 1.10, p = .28$).

RQ3: Suggestion usage and its influence on conversation experience

Participants' use of the suggestions during conversations
 For sessions during which participants received suggestions, how did they use these suggestions in their conversations? Each participant received an average of 15 suggestions during a 15-minute conversation session ($SD = 6.34, Min = 6, Median = 15, 90th\ percentile = 24, Max = 31$). On average, in sessions where suggestions were delivered, we found that participants used on average 3.46 suggestions, or 23% of the suggested topics ($SD = .21, Min = 0, Median = .18, 90th\ percentile = .58, Max = .82$). Half of the pairs received suggestions only in the first session. , In these pairs, during the second session, participants reused on average 1.68 suggestions or 12% of the suggestions they got in the first session ($SD = .14, Min = 0, Median = .07, 90^{th}\ percentile = .33, Max = .50$).

We compared the percentage of delivered suggestions that were adopted by participants afterwards during the first session (when two speakers are complete strangers) and the second conversation session (after they have gone through the initial icebreaking phase). We used a mixed effect general linear regression of Poisson distribution, with the session order (first or second) as the fixed effect, and the pair as the random effect. We conducted this analysis only on the data from sessions during which participants received suggestions ($N = 76$). We found that participants adopted a significantly higher ($z = 2.50, p = .01$) percentage of the suggestions in the first session ($M = .21, SE = .22$) than in the second session ($M = .10, SE = .14$).

Effects of number of used suggestions on conversation experience

We conducted a mixed-effect linear regression on the self-

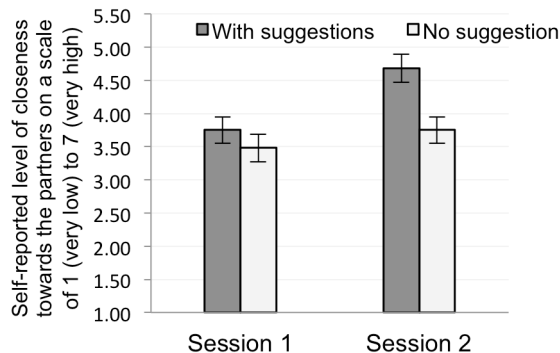


Figure 5. Participants' reported level of closeness to their partners in two conditions during the 1st and the 2nd

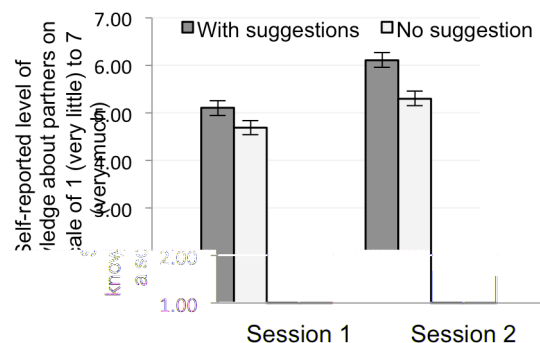


Figure 6. Participants' reported level of knowledge about their partners in two conditions, during the 1st and 2nd sessions.

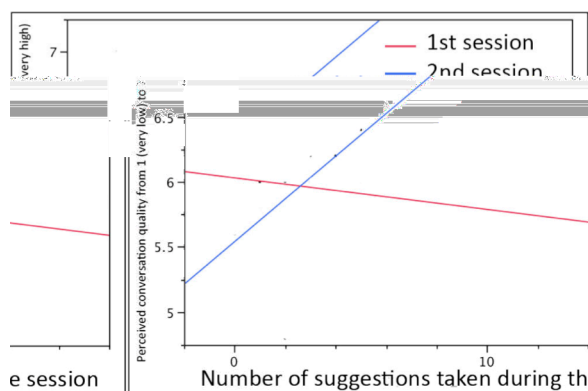


Figure 7. Perceived conversation quality as a function of the number of suggestions taken during the 1st and 2nd

reported level of liking for the session, perceived conversational quality, closeness to the partners, and knowledge about the partners as a person. We included as the fixed effects the order of the session (first or second), the number of suggestions that participants took, and the interaction between the two. The random factor is the pairs.

While we did not find any significant effect of the number of suggestions used on the level of liking of the session, perceived closeness to the partners, and knowledge of the partners as a person, we found a significant positive effect of the number of suggestions taken on the perceived quality of the conversation ($\beta = 1.06$, $SE = .35$, 95% CI [.37, 1.75], $F[1, 64.97] = 8.84$, $p < .01$). The more suggestions participants took, the better the quality of the conversation they reported having. Moreover, we also found a significant interaction effect of the session order, and the number of suggestion taken (β [for first session] = -1.16, $SE = .35$, 95% CI [-1.85, -.47], $F[1, 64.97] = 10.59$, $p < .01$). Figure 7 shows that those who received suggestions in the second session perceived the conversation quality to be better with more suggestions. However, those who received suggestions in the first session did not perceive the quality to change significantly with the number of suggestions.

Indeed, a mixed effect linear regression on the data from only the first session revealed no significant effect of the number of suggestions taken on the perceived quality of the conversation in the first session ($F[1,39] < 1$, n.s). On the other hand, a mixed effect linear regression on the data from only the second session, controlling for the perceived conversation quality reported in the first session, showed that the number of suggestions taken had a significant positive effect on the perceived quality of the conversation in the second session ($\beta = .16$, $SE = .04$, 95% CI [.08, .23], $F[1, 34] = 19.69$, $p < .001$) (see Figure 7). The more suggestions participants used during the second session, the higher the reported conversation quality.

Comments from the participants about the suggestions

Participants left comments about the suggestions that they received during their conversations. These comments reflected what we found with our quantitative analyses.

Three main findings emerged from these comments. First, participants found the suggestions useful, and that the suggestions helped them find discussion topics when they ran out of subjects during the 2nd session. Second, participants found the equipment and the suggestions distracting at times. Third, many participants thought the suggestions were useful for introverts but not extroverts. We presented the findings and comments in Table 2.

DISCUSSION

The effect of topics suggestions on conversations between strangers

Although participants thought topic suggestions were helpful, their communication behaviors, self-reported conversation experience, and the comments they left present a more complex story. First, we found that participants adopted more suggestions during the first 15-minute conversation session when both participants knew little of each other than during the second session. As the suggestions provided topics both of them might be interested in, participants might have used the suggestions to support the process of developing mutual knowledge about each other, and laying the groundwork for further conversation contents, as suggested by Clark et al. [5]. The comments from the participants also illustrated how the suggestions “guided” them “to sub-conversations”, and helped them know each other better. In contrast, we found that during the first session, participants who received suggestions did not report a better experience than those who did not receive suggestions. Perhaps during the first session, participants were able to navigate the ice-breaking phase on their own with safe “setting topics” [22]. Suggestions might have created additional pressure and awkwardness over the natural pressure of a first meeting, as participants might feel compelled to use suggestions when they appeared. Additionally, as some of them commented, it felt awkward to lose eye contact and glance at the suggestions while trying to maintain a fluid conversation. This reflects the challenges when designing technologies to foster conversations, as mobile, wearable devices have been found to create disruptions in human interactions [24].

On the other hand, in the second session, participants who received suggestions reported a better experience than those who did not. After some time familiarizing with the partners, participants might have been able to use the suggestions more selectively to start interesting discussions with less awkwardness than the first session. Some participants commented that in the second sessions the suggestions helped them find new things to talk about when they ran out of topics. This finding is also consistent with the result that during the second session, the more suggestions participants used, the better the conversation qualities they reported. An alternative explanation for our finding may be that participants felt compelled to use the suggestions and thought the conversations to be better with suggestions because they knew they and their partners would receive suggestions. However, this alternative

Themes	Example comments from participants
Suggestions were useful.	<ul style="list-style-type: none"> • <i>It is good to have something to fall back on when other conversational gambits might fail. (P94, suggestions during the 2nd session)</i> • <i>I think the system did help introduce common interests, especially when [we ran out of topics during the previous conversations]. Overall, the second session was easier because of it. (P119, suggestions during the 2nd session)</i>
Equipment and suggestions created distractions.	<ul style="list-style-type: none"> • <i>I think the suggestions were helpful, but maybe too 'invasive'? I felt like I needed to use them & changed topic more often than I wanted. (P55)</i> • <i>The suggestions need to take into account the current conversation & content. I found the suggestions were not related and using them would break the flow. (P96)</i> • <i>The biggest drawback to the google glass was that [my partner] was looking at the Glass sometimes instead of me, so it's feels more awkward. (P132)</i> • <i>While it was beneficial to have the [suggestions], it felt unnatural having to avert eye contact to look at them. (P106)</i>
Introverts would benefit from suggestions, but not extroverts.	<ul style="list-style-type: none"> • <i>For people more introverted, I think something like this could be very helpful. (P117)</i> • <i>In situations where two people feel shy, somewhat awkward or nervous, topics of mutual interest can encourage fluid dialogue and a more natural conversation. (P80)</i> • <i>The glass could be helpful for people who are not social. But for social people, glasses are distracting and bothersome. (P102)</i> • <i>I prefer without suggestions as I am relatively outgoing, but I can see how they would be helpful for people who have difficulties the first time they meet someone. (P105)</i>

Table 2: Summary of comments from participants

explanation cannot account for the findings that more suggestions were used in the first session than the second session, and that in the first session the suggestions did not make any difference in conversational experience.

Our study tested how the system performed both in the first and second sessions, i.e. during and after the ice-breaking phase. This sets our study apart from previous studies [e.g.,11] about systems to help strangers initiate conversations, in other words, only during the ice-breaking phase. In fact, the focus of our system is to foster conversational experience not during, but after ice breaking. Our results showed that the system achieved this goal in several aspects.

Our results thus provide preliminary evidence that the suggestions may be helpful for strangers to continue having interesting conversations after the initial ice-breaking phase. However, our results also cautioned about the awkwardness and disruptions that suggestions might cause when delivered in certain ways at certain points of time during the conversation. When two strangers first meet, most go through a typical getting-to-know-you exchange, asking familiar, almost routine questions about location, family, or work (as one participant remarked) [22]; and they can do this naturally without suggestions. Introducing suggestions in this phase, especially suggestions that require occasional averting of eye contact from the partners could interfere with the normal conversational flow and have an adverse effect on speakers' experience.

Effects of suggestions on introverts and extroverts

Another interesting result was the difference in the effect of suggestions on introverts and extroverts. When participants received suggestions, participants who scored higher on the introversion scale reported a higher perceived conversation quality. The reverse relationship was true when there was

no suggestion. So the suggestion seemed to have helped introverted participants enjoy the conversation more, perhaps by encouraging exploration of a diverse array of conversational topics, as introverts tended to shy away from deeper topics after the initial ice-breaking phase. This is consistent with the comments our participants provided.

But as the introversion scale is the inverse of the extroversion scale, this result also suggests that the more extroverted the participant, the lower the perceived conversation quality. Extroverts, who naturally enjoy interactions with others, are probably able (and may even prefer) to direct the conversation on their own [23]. They may find the suggestions distracting and bothersome as our participants commented.

In summary, our results contribute to the understanding of how conversational interventions such as providing topic suggestions influence the behaviors and experience of the speakers. Our study calls attention to not only the benefits of conversational interventions, but also the drawbacks of these techniques, and the various factors such as speakers' personalities and interface design that influence the usability of these interventions.

LIMITATIONS & FUTURE DIRECTIONS

Our study is not without limitation. Our sample was limited to those who had LinkedIn profiles because we had to collect LinkedIn user data. The constraint about the topics they couldn't discuss was somewhat unnatural for the first conversation, but was necessary to examine the effects of the suggestions.

For the next steps, we hope to develop a detailed coding scheme for the transcripts of the conversations and analyze the topics discussed when the pairs received suggestions, and when they did not. We also want to analyze the non-

Research Questions		Findings
1	Did participants find the suggestions useful?	Somewhat useful. Participants were not concerned about the information we collected from them for the study.
2	How do suggestions affect the conversational experience (regardless of whether participants use the suggestions)?	Positive effects on conversational experience but only during 2 nd session: Significantly higher perceived conversation quality, closeness to partners, and knowledge of partners with suggestions than without.. Introverted participants benefited from the suggestions, but extroverted participants did not.
3	How did participants use the suggestions they received?	Participants adopted a significantly higher percentage of the suggestions in the 1 st session than in the 2 nd .
	Does the number of suggestions used matter?	Those who received suggestions in the 2 nd session perceived the conversation quality to be better with more suggestions. However, those who received suggestions in the 1 st session did not perceive the quality to change significantly with the number of suggestions.

Table 3: Summary of main findings.

verbal behaviors of the participants from the video recordings of the conversations. In future studies, we would like to conduct the study in more natural settings such as at coffee shops, parties or conferences, and where participants may not be aware that their partners receive suggestions. We also wonder if topic suggestions in the form of images instead of text, similar to IdeaExpander [26], could help improve participants' experience and how. Lastly, the current system delivered the best suggestions first. We did not test how such order of delivery influenced the conversations. Thus, it may be interesting to explore the optimal order of suggestions.

DESIGN IMPLICATIONS

First, our results demonstrate the benefits of a system that provides personalized suggestions during conversations between strangers. Such systems can make use of personal details about each person that can be collected easily from simple pre-questionnaires, or from public profiles on social network sites such as LinkedIn, and apply well-known techniques from recommender systems. These systems may be useful, especially for people who are shy and reserved, to make friends in informal contexts, such as at academic conferences, social events, or after moving to a new place.

However, our results also show that topic suggestions were only beneficial when shown at the right moment, and could even backfire by creating distractions and disruptions in the current conversational flow. Thus, a topic suggestion system should also be able to closely monitor the ongoing conversation to detect when to intervene (e.g. when both speakers run out of things to discuss and silences emerge). Previous studies ([14]) show that it is possible to detect speakers' engagement in conversations based on the conversational content. There have been several systems that monitor the emotions and behaviors of speakers in a conversation ([29, 2]). The topic suggestion mechanism can be integrated with these systems to support more rewarding interaction between strangers. Speakers could even train the system to recognize their conversation style by turning on or off suggestions as they please.

Although our participants found the topic suggestions useful, they disliked that these suggestions were not in sync

with the ongoing content of the conversations, resulting in distractions. To reduce the invasiveness, and increase the benefits of suggestions, systems should propose topics to speakers related to the current flow the conversation. Dynamic suggestions, intelligently adapted to ongoing the conversational content, may even spark new ideas for speakers and broaden their conversation [26]. Moreover, systems should display suggestions according to the quality of the conversation. If the conversation is flowing without suggestion, there is no need for intervention.

Our results also cautioned about the different, even opposite, effects of suggestions on different types of speakers' personalities. Extroverts felt the suggestions were bothersome and distracting, while introverts were more receptive towards them and found them useful. So topic suggestion systems should learn the speakers' personalities to decide whether and when to deliver suggestions. Another possibility is to allow users to disable the topic suggestions if they want. Our study calls attention to the important role of collocutors' personalities in the design and use conversation interventions.

Lastly, wearable technologies enable people to receive multiple channels of information during a conversation in an unobtrusive manner. However, we found that some participants felt uncomfortable diverting their eyes to look at the device, or seeing their partners looking at the device instead of them. We wonder if other wearable technologies that are less invasive to one-on-one conversation, such as smart contact lens [16], could help ease the uncomfortable feelings and improve the conversation experience.

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REFERENCES

1. Altman, I., & Taylor, D. A. (1973). *Social penetration: The development of interpersonal relationships.*, Oxford: Holt, Rinehart & Winston.

2. Bergstrom, T., & Karahalios, K. (2007). Conversation Clock: Visualizing audio patterns in co-located groups. *Proc. HICSS '07*, 78-78.
3. Burgoon, J. K., & Hale, J. L. (1987). Validation and measurement of the fundamental themes of relational communication. *Communication Monographs*, 54, 1, 19-41.
4. Clark, H. (1992). *Arenas of Language Use*. Chicago: The University of Chicago Press & CSLI.
5. Clark, H. H., & Brennan, S. E. (1991). Grounding in communication. *Perspectives on socially shared cognition*, 13, 127-149.
6. Gosling, S. D., Rentfrow, P. J., & Swann Jr, W. B. (2003). A very brief measure of the Big-Five personality domains. *Journal of Research in personality*, 37, 6, 504-528.
7. Goffman, E. (1967). On face-work. In *Interaction Ritual: Essays on Face-to-Face Behavior*, 5-46. New York: Pantheon.
8. Granovetter, M. S. (1973). The strength of weak ties. *American Journal of Sociology*, 1360-1380.
9. Hannon, J., Bennett, M., & Smyth, B. (2010). Recommending twitter users to follow using content and collaborative filtering approaches. *Proc. RecSys '12*, 199-206.
10. Manning, C. D., Surdeanu, M., Bauer, J., Finkel, J., Bethard, S. J., & McClosky, D. (2014). The Stanford CoreNLP Natural Language Processing Toolkit. *Proc. ALC'14*, 55-60.
11. McCarthy, J. (2002). Using public displays to create conversation opportunities. *Proc. CSCW'02 Workshop*.
12. McLaughlin, M. L., & Cody, M. J. (1982). Awkward silences: Behavioral antecedents and consequences of the conversational lapse. *Human Communication Research*, 8, 4, 299-316.
13. Nguyen, T. T., Kluver, D., Wang, T. Y., Hui, P. M., Ekstrand, M. D., Willemsen, M. C., & Riedl, J. (2013). Rating support interfaces to improve user experience and recommender accuracy. *Proc. RecSys '13*, 149-156.
14. Nguyen, D. T., & Fussell, S. R. (2014). Lexical Cues of Interaction Involvement in Dyadic Instant Messaging Conversations. *Discourse Processes*, 51, 468-493.
15. Ofek, E., Iqbal, S. T., Strauss, K. (2013). Reducing Disruption from Subtle Information Delivery during a Conversation: Mode and Bandwidth Investigation. *Proc. CHI'13*, 3111-3120.
16. Parviz, B., Tan, D. (2011). Functional Contact Lens Monitors Blood Sugar Without Needles http://research.microsoft.com/en-us/collaboration/stories/nui_contactlens_cs.pdf, retrieved 2014-09-17.
17. Powell, E., Brinkman, R., Barnes, T., & Catete, V. (2012). Table tilt: making friends fast. *Proc. FDG'12*, 242-245.
18. Resnick, P., Iacovou, N., Suchak, M., Bergstrom, P., & Riedl, J. (1994, October). GroupLens: an open architecture for collaborative filtering of netnews. *Proc. CSCW 94*, 175-186.
19. Rhodes, B. J. (1997). The wearable remembrance agent: A system for augmented memory. *Personal Technologies*, 1, 4, 218-224.
20. Rhodes, B. J., Minar, N., & Weaver, J. (1999). Wearable computing meets ubiquitous computing: Reaping the best of both worlds. *Procs. of the 3rd International Symposium on Wearable Computers*, 141-149.
21. Sunnafrank, M. J., & Miller, G. R. (1981). The role of initial conversations in determining attraction to similar and dissimilar strangers. *Human Communication Research*, 8, 16-25.
22. Svennevig, J. (2000). *Getting acquainted in conversation: a study of initial interactions (Vol. 64)*. Amsterdam: John Benjamins Publishing.
23. Thorne, A. The press of personality: A study of conversations between introverts and extraverts. *Journal of Personality and Social Psychology*, 53, 718-726.
24. Tolmie, P., Crabtree, A., Rodden, T., & Benford, S. (2008). "Are you watching this film or what?": interruption and the juggling of cohorts. *Procs. CSCW '08*, 257-266.
25. Vig, J., Sen, S., & Riedl, J. (2012). The tag genome: Encoding community knowledge to support novel interaction. *Proc. TIIS*, 2, 13.
26. Wang, H. C., Cosley, D., & Fussell, S. R. (2010, February). Idea Expander: Supporting group brainstorming with conversationally triggered visual thinking stimuli. *Proc. CSCW '10*, 103-106.
27. Weiss, R. S. (1973). *Loneliness: The experience of emotional and social isolation*. Cambridge: MIT Press.
28. Wu, Z., & Palmer, M. (1994). Verbs semantics and lexical selection. *Proc. ACL' 94*, 133-138.
29. Yeo, Z. (2008). Emotional instant messaging with KIM. *CHI'08 Extended Abstracts*, 3729-3734.
30. Yoon, J., Oishi, J., Nawyn, J., Kobayashi, K., Gupta, N. (2004). FishPong: encouraging human-to-human interaction in informal social environments. *Proc. CSCW '04*, 374-377.
31. Yuan, C. W., Setlock, L. D., Cosley, D., & Fussell, S. R. (2013). Understanding informal communication in multilingual contexts. *Proc. CSCW '13*, 909-92