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Comparing Group Discussion in Virtual and Physical Environments

Abstract

One of the main promises of collaborative virtual environments (CVEs) is that they would decrease the need for travel and face-to-face meetings. In this study we aim at comparing the dynamics and content of group discussions in desktop virtual environments with physical-world discussions. We have conducted an experiment in which four groups of 7–12 participants each carried out a political discussion on the same topic; specifically, global warming. Two groups conducted the experiment in a face-to-face setting and two other groups conducted a similar discussion inside the virtual world SecondLife (http://www.secondlife.com). Virtual-world discussions were found to include shorter sentences on average, have a smaller number of themes discussed, discuss a smaller number of themes in depth, and require a longer time for discussion threads to form. In this paper we provide a quantitative analysis of the similarities and differences between virtual-world and physical-world discussions.

1 Introduction

One of the main promises of collaborative virtual environments (CVEs) is that they would decrease the need for travel and face-to-face meetings. Moreover, such platforms can serve as a meeting point for groups that cannot meet in the physical world, such as groups that are involved in violent conflicts. There has been extensive research dealing with collaboration in virtual environments, but little attention has been given to the nature and content of discussions. In this study, we aim at comparing the dynamics and content of group discussions in desktop virtual environments with physical-world discussions.

We have conducted an experiment in which four groups of 7–12 participants each carried out a political discussion on the same topic; specifically, global warming. Two groups conducted the experiment in a face-to-face setting and two other groups conducted a similar discussion inside the virtual world SecondLife (SL). In this paper, we provide a quantitative analysis of the discussions and some conclusions regarding the differences between virtual-world and physical-world discussions.

Several researchers have emphasized the importance of studying online virtual worlds (Blascovich et al., 2002; Bainbridge, 2007). While CVEs have been popular since the 1980s (e.g., Morningstar & Farmer, 1991, Active Worlds, http://www.activeworlds.com), it is only in the last few years that this

Presence, *Vol. 18, No. 4, August 2009,* 286–293

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medium has come to the reach of millions. Thus, we believe it is now crucial to study persuasion processes in CVEs, and the possibility of virtual worlds to be used for public discussion of pressing issues. For a video describing a political demonstration in SecondLife, see https://portal.idc.ac.il/en/schools/Communications/research/Virtuality/Pages/VideoClips.aspx, video titled "Anti-Israeli demonstration in Second Life."

2 Background

The psychological analysis of group discussions usually focuses on social influence and persuasion. Social influence refers to the change in one's attitudes, behavior, or beliefs, due to external pressure that is real or imagined (Cialdini, 2001). Persuasion describes an area of social influence that is focused on the change in a private attitude or belief as a result of receiving a message (Cialdini).

Persuasion researchers have proposed dual-process models of persuasion—that there are two primary ways in which individuals process information: centrally (also called systematic processing) or peripherally (also called heuristic processing; Petty & Cacioppo, 1984, 1986; Chaiken, Wood, & Eagly, 1996). Nonverbal communication (NVC) plays a critical role, mainly through the peripheral channel. NVC includes postures, gestures, facial expressions, gaze, and proxemics. Gaze is highly important (Kleinke, 1986; Segrin, 1993); there is ample evidence that a person who uses direct eye gaze gains advantage in terms of social influence (Fry & Smith, 1975; Morton, 1980; Bull & Gibson-Robinson, 1981; Segrin), and there is also corresponding evidence in immersive virtual reality (VR; Garau, Slater, Bee, & Sasse, 2001).

NVC is one of the main factors responsible for the differences between virtual-world meetings and physical-world meetings. In highly-immersive VR environments, it may be possible to track the participants and apply their body language to the avatars representing them at the remote end. Such functionality is, of course, rarely applied in typical desktop-based CVEs, and the result is an awkward situation: participants are represented as animated avatars, and these avatars demonstrate NVC. However, this NVC has no correlation with the NVC of the real participant. Some research works have attempted to base the NVC of such conversational agents on the nature of the conversation as extracted automatically from the text (Cassell et al., 1999; Cassell, Vilhjálmsson, & Bickmore, 2001), but this approach has some limitations, mainly due to the limitations in understanding natural language dialogue. In addition, it is not accessible beyond the laboratory, in publicly available CVEs.

The results of such arbitrary automated generation of NVC can be misleading. For example, a participant may be extremely confident, but somehow that person's avatar may render him or her with insecure NVC, which would result in undesired communication effects. In fact, Bailenson, Beall, Blascovich, Loomis, and Turk (2005) show how such automated generation of NVC can provide a participant with superior communication abilities, by allowing his or her avatar to use personalized eye contact with each of several remote participants simultaneously.

A possible exception to the limitation of NVC in virtual worlds is the distance among participants in virtual space. This is referred to as proxemics, which is considered a subset of NVC, and has been studied by social psychologists in physical-world settings (Hall, 1959, 1966). Yee, Bailenson, Urbanek, Chang, and Merget (2007) have uncovered patterns of proxemics that would be expected in the real world, such as gender differences, and eye-gaze avoidance for situations where the interpersonal difference is only 2–4 m. Similar research using automated software bots (Friedman, Steed, & Slater, 2007) also revealed a spatial social aspect in SL, although differences have been reported between physical- and virtual-world behavior.

Another major difference between virtual and physical discussions is the possibility of maintaining anonymity online. Anonymity and online persuasion have been studied (e.g., Guadagno & Cialdini, 2005), but there is no research as to whether CVEs are different from other online platforms in this respect.

The results from these studies are emerging into a picture: human behavior in non-immersive virtual worlds, and particularly persuasion and social influence, are similar, but not identical to human behavior in the physical world. Our preliminary hypothesis is that there

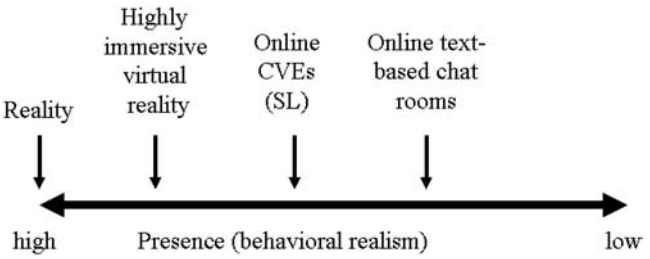

Figure 1. *The behavioral realism spectrum.*

is a spectrum stretching from low-fidelity online platforms, such as text-based chat rooms, through CVEs, to reality (see Figure 1). We hypothesize that this spectrum corresponds to the level of presence, defined as behavioral realism (Sanchez-Vives & Slater, 2005).

Of course, this hypothesis needs verification, and, even if supported, there are still many missing details. Mainly, the spectrum hypothesis may only help us predict whether behavior in a given medium is expected to be similar to real world behavior or not. If, however, there is a difference, it does not tell us of the nature of this difference. In our case, does lack of presence result in a higher or lower tendency to be persuaded? For example, work by Walther and colleagues described how computer-mediated communication (CMC) interactions in chat rooms can be hyperpersonal, that is, more intimate, salient, and intense than face-to-face interaction (Walther & Burgoon, 1992; Walther, 1996). Based on our spectrum hypothesis above, we predict that CVEs would allow for hyperpersonal experiences, but to a lesser degree than chat rooms; this needs verification.

Note that this spectrum is very different from Milgram and Kishino's (1994) well-known spectrum. The latter is a technological spectrum, whereas ours is behavioral. Also, we recognize that this spectrum is most likely an oversimplification. A more realistic model would probably be multidimensional.

3 Method

3.1 Subjects

36 students, 21 females and 15 males (age 19–27, mean = 23.8, *SD* = 1.65), were recruited on campus, and received either course credit or payment (equivalent to $10). The study was approved by the institutional ethics committee.

3.2 Experimental Conditions

The subjects were randomly assigned into four groups: two groups (P1 and P2, with nine and eight participants, respectively) held a discussion in a physical meeting room and two other groups (V1 and V2, with seven and 12 participants, respectively) held a discussion in SL.

3.3 Procedure

All four group discussions took place on the same day, following a few days of pilot experiments. The pilot sessions were necessary to resolve technical issues around SL, such as performance, participant practice, language, recording of the sessions using video, audio, and images, and capturing the text.

The topic of the discussion was global warming and its implications on our everyday lives. The subjects in both conditions were instructed that they had one hour after which they had to reach a consensus whether they were ready to decrease their car usage in order to address climate change. All discussions were carried out in English. (The subjects' first language was Hebrew, but right-to-left typing is not supported in SL.) Before the experiment, each subject filled in a preliminary questionnaire (including demographics, background with video games and virtual worlds, and English language fluency) and a short questionnaire that assessed their view of global warming (Appendix A).

The physical-world discussions were conducted in a staff meeting room (see Figure 2a) and were recorded by a video camcorder on a tripod. The experimenters watched the discussion from another room during the discussion but decided not to intervene at any point. Following the experiment, the conversation was transcribed.

The discussions in SL required more preparations. Twenty avatars with anonymous names were prepared in advance, half of them males and half females, so that each subject was assigned an avatar with matching gender. Subjects entered simultaneously into a virtual meet-

(a)

(b)

Figure 2. *(a) The physical meeting room. (b) The virtual meeting room.*

ing room (see Figure 2b); and each was asked to be seated in front of a PC, which was already logged on to SL with the corresponding avatar. (The fact that subjects were physically located in the same room is not ideal and was the result of technical constraints. We did make sure that subjects were not too close to each other, i.e., no two subjects sat in adjacent seats.) The experimenters watched the experiment by means of logging in using another avatar, from a different physical room. The discussions were held using typed text in online chat style, as part of the SL client application. (Our experience indicates that it is still difficult to hold a voice meeting in SL when there is a large group of people. However, this is one of the factors we expect to study in the future.) The session was captured by video-recording the display, and by recording the text separately into a file.

All subjects filled in the same global warming questionnaire (Appendix A) after the discussion. Subjects in the SL condition also filled in a questionnaire intended to assess their presence in the virtual world; this was a collection of 17 questions taken from the SUS questionnaire (Slater, Usoh, & Steed, 1994) and the Witmer-Singer questionnaire (Witmer & Singer, 1998). We incorporated all questions that would apply to our scenario and those related to place illusion and co-presence.

4 Results

4.1 Questionnaires

We have carried out a Wilcoxon signed rank test comparing the global warming questionnaires before and after the sessions. In all groups, there was an increase in the concern for global warming following the discussion; this was significant for questions 1–3 ($p = .001$, $p = .022$, and $p = .035$), and nearly significant for question 4 ($p = .06$). No significant difference was found for questions 5–7 ($p = .259$, $p = .759$, and $p = .384$). The increase in the responses to the questions was larger in the physical world groups than in the virtual world groups, but this difference was not found significant in a one-way ANOVA ($F = 2.921$, $p = .0907$).

Presence questionnaires were only filled in by the subjects in the virtual-world condition, since we assume all subjects are completely present in the physical world; thus, these questionnaires were mainly administered for future use. The questions are all on a Likert scale of seven items. For each subject, we counted the extreme answers (1, 2, 6, and 7). This reveals that three subjects reported high presence, 10 subjects reported low presence, and for the remaining six subjects in the virtual-world groups the results are not clear cut. There were no significant differences in reported presence with respect to group or gender.

Table 1. *Word and Sentence Count in the Four Experimental Groups*

Group	Words per minute	Average length of sentence	Sentences per minute
V1	76	5.3	14.5
V2	61	5.1	12
P1	130	8.7	14.8
P2	140	11.9	11.7

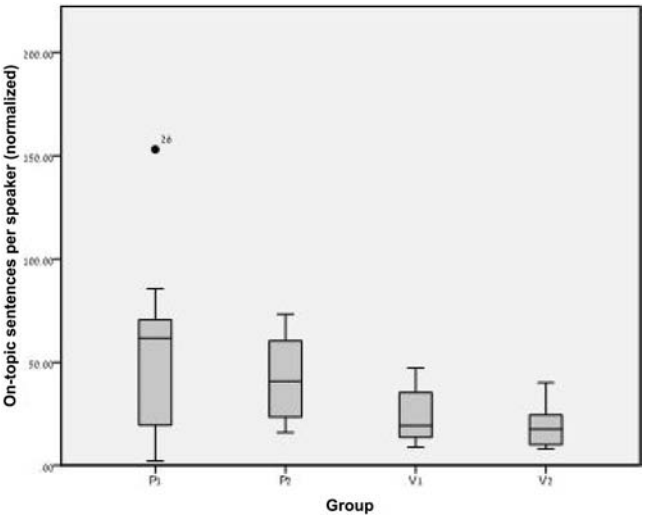

Figure 3. *Number of on-topic sentences per speaker, normalized by group size, in the four different experimental groups.*

4.2 Word and Sentence Count

Table 1 shows the words per minute, average sentence length, and number of sentences per minute in each of the four groups. A larger number of groups is required for statistical analysis, but the pattern seems robust: the number of sentences in both conditions are more or less the same, and the sentences in the virtual setting are much shorter than the sentences in the physical world; as a result, the number of words per minute is also much smaller in the virtual world than in the physical world.

One of the physical world groups shifted from English to Hebrew in the last few minutes (this duration was not taken into account in the data in Table 1). This allowed us to compare the number of words per minute, which grew to 150, that is an increase of only 10%.

A one-way ANOVA indicates that there was no difference in the number of sentences per speaker, normalized by group size ($p = .768$; normalization was done by multiplying each number by $n/12$, where n is the number of participants in the group). However, the number of on-topic sentences per speaker, normalized by group size, was significantly higher in the physical-world condition than in the virtual-world condition ($p = .003$), and so was the number of words per speaker, normalized by group size ($p = .011$). The normality of the speaker distribution in all groups was not violated, using a Kolmogorov-Smirnov test (all $p > .77$).

Figure 3 shows the number of on-topic sentences per speaker, normalized by group size, in the four different groups. The number of on-topic sentences in the virtual-world groups was much smaller than in the physical-world groups; this is unlike the overall sentence count, which was similar in both conditions. In addition, the dominant speaker in group P1 is also dominant in terms of the number of on-topic sentences; however, this is not the case for the dominant speaker in group V1. This suggests that the dominant speaker in P1 served to keep most of the discussion on topic, whereas the dominant speaker in group V1 might have kept the discussion off topic.

4.3 Response Time

Based on the videorecordings, we measured discussion response times, that is the time from the first moment a new topic was raised until someone else picked up the same thread. We asked students who had no notion of the goals of this research to perform this measurement; they recorded 30 such cases where such topic changes were clear, 15 in each condition. In the virtual world, the response times were between 6.5 and 25.5 s (mean = 12.1 s, $SD = 4.63$). In the real world, such topic changes, if they occurred, always took place for less than 1 s.

4.4 Thematic Analysis

We have performed a thematic analysis of the discussions; research assistants who were not informed of

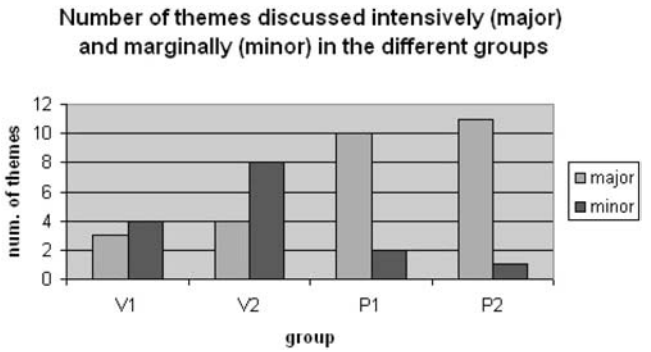

Figure 4. *The number of themes that came up in each group. Themes that were discussed in depth are referred to as major, and themes that only came up superficially are referred to as minor.*

the goals of the study reviewed the transcribed discussion texts and identified the themes that appeared in the discussions, according to two categories: major (themes that were discussed relatively in depth) and minor (themes that were discussed only superficially). Figure 4 indicates that the physical-world groups had more themes discussed in depth, whereas the virtual-world groups had more themes discussed superficially. Overall, the physical-world groups raised more themes.

4.5 Observations

All groups were videorecorded. Observing the physical-world discussions, it is clear that subjects remained seated and seemed concentrated on the discussion throughout the discussion. Observation of the virtual-world discussions reveals a very different pattern: avatars representing subjects stand up, wander around the room and to the next room, fly in the air, sit and stand on the table, change their appearance (including, in one case, taking their clothes off), laugh, whistle, and dance. In one of the pilot groups all the subjects, while still in front of the desktop computers in the physical world, eventually left the virtual meeting room and gathered in the virtual swimming pool.

(A video summary of the experiment can be found in https://portal.idc.ac.il/en/schools/Communications/research/Virtuality/Pages/VideoClips.aspx, video titled "SecondLife.")

5 Discussion and Future Work

Our study illustrates that there was a wide difference in behavior in the physical-world meetings when compared to the virtual-world meetings. Opinion regarding global warming changed to a larger degree following the physical-world discussion, but this difference was not significant. The results indicate that the number of sentences in the virtual world was not different from the number of sentences in the physical world. However, the sentences in the virtual world were, on average, very short, and a larger percent of the sentences was unrelated to the discussion. Thus, the amount of on-topic information exchanged by the participants in the virtual-world discussions was smaller than in the physical world. We found that the number of in-depth themes covered was much smaller in the virtual world. We have also shown that the response time, defined as the time required for participants to pick up on a new theme, was quite large in the virtual world, whereas this was almost instantaneous in the physical world.

In addition to the quantitative measures, we also observed an overt difference in the behavior of the groups. While the two groups in the physical world displayed behavior typical to a discussion, the subjects in the two virtual discussion groups displayed behavior that we would not expect in a real world discussion, and, in one case, even opted to leave the meeting room altogether.

Some of the measurements pointed to possible similarities between the physical- and virtual-world discussions. Our analysis did not find a striking difference in the social dynamics between groups, that is, both conditions seemed to have the same distribution of speakers and to have a dominant speaker; this is in accordance with real-world discussion dynamics.

This study can serve as a baseline for further studies, trying to establish whether virtual worlds can serve as a useful platform for discussion. First, we note that even though the discussion in the virtual world was more superficial, it seems to have been at least partially effective—we see that even in the virtual-world groups there was a significant change of opinions following the discussion. Since in some cases face-to-face meetings are practically impossible, it does seem that virtual worlds

may offer a substitute. Moreover, our baseline study may serve to highlight what aspects of the discussion need to be addressed.

The results reported here are in line with our mediated spectrum hypothesis, described in Section 2, which states that behavior in non-immersive CVEs, although sometimes resembling behavior in an equivalent physical-world situation, is significantly different. We are now working toward a follow-up study, in which we compare SL discussions with online chat discussions (typed-text only)—our hypothesis predicts that text-only discussions will be yet further away from physical-world discussions along the spectrum. Further study needs to establish whether discussions held in more immersive settings, rather than in SL, are closer to physical world discussions. An additional factor we expect to examine in the coming study is anonymity.

Eventually, we expect this line of research to address what we consider the two major questions: under what conditions can virtual-world discussions replace physical-world discussions, and, in other cases, how would the nature of the environment impact the dynamics and content of the discussions. As more people populate virtual worlds daily, these questions are not only of theoretic interest but also of immediate social consequence.

Acknowledgments

This study was supported by the UNLV-IDC Brian Greenspun collaboration seed fund. We would like to thank Susanna Priest and Lawrence Mullen of UNLV for their useful insights. We would also like to thank Tomer Hendl and Ran Stone for their technical and logical support in carrying out the study, and students of the virtual-worlds seminar: Ari Dubin, Dani Inbar, Yoni Kalosky, and Michelle Lourie.

References

Bailenson, J., Beall, A. C., Blascovich, J., Loomis, J., & Turk, M. (2005). Transformed social interaction, augmented gaze, and social influence in immersive virtual environments. *Human Communication Research, 31*(4), 511–537.

Bainbridge, W. S. (2007). The scientific research potential of virtual worlds. *Science, 317,* 472–476.

Blascovich, J., Loomis, J., Beall, A., Swinth, K., Hoyt, C., & Bailenson, J. (2002). Immersive virtual environment technology as a methodological tool for social psychology. *Psychological Inquiry, 13,* 146–149.

Bull, R., & Gibson-Robinson, E. (1981). The influence of eye gaze, style of dress, and locality on the amounts of money donated to charity. *Human Relations, 34,* 895–905.

Cassell, J., Bickmore, T., Billinghurst, M., Campbell, L., Chang, K., Vilhjálmsson, H., et al. (1999). Embodiment in conversational interfaces: Rea. *ACM SIGCHI,* 520–527.

Cassell, J., Vilhjálmsson, H. H., & Bickmore, T. (2001). BEAT: The behavior expression animation toolkit. *ACM SIGGRAPH,* 477–486.

Chaiken, S., Wood, W., & Eagly, A. H. (1996). Principles of persuasion. In E. T. Higgins & A. W. Kruglanski (Eds.), *Social psychology: Handbook of basic principles* (pp. 702–744). New York: Guilford.

Cialdini, R. B. (2001). *Influence: Science and practice*. New York: Harper-Collins.

Friedman, D., Steed, A., & Slater, M. (2007). Spatial social behavior in Second Life. In *Proceedings of Intelligent Virtual Agents,* LNAI 4722, 252–263.

Fry, R., & Smith, G. F. (1975). The effects of feedback and eye contact on performance of a digit-encoding task. *Journal of Social Psychology, 96,* 145–146.

Garau, M., Slater, M., Bee, S., & Sasse, M. A. (2001). The impact of eye gaze on communication using humanoid avatars. *ACM SIGCHI,* 309–316.

Guadagno, R. E., & Cialdini, R. B. (2002). Online persuasion: An examination of gender differences in computer mediated interpersonal influence. *Group Dynamics: Theory, Research, and Practice, 6,* 38–51.

Guadagno, R. E., & Cialdini, R. B. (2005). Persuasion and attitude change on the internet. In Y. Amichai-Hamburger (Ed.), *The social net: The social psychology of the internet* (pp. 91–113). Oxford, UK: Oxford University Press.

Hall, E. T. (1959). *The silent language*. New York: Doubleday.

Hall, E. T. (1966). *The hidden dimension*. New York: Anchor.

Kleinke, L. (1986). Gaze and eye contact: A research review. *Psychological Bulletin, 100,* 78–100.

Milgram, P., & Kishino, F. (1994). A taxonomy of mixed reality visual displays. *IEICE Transactions on Information Systems, E77-D* (12), 1321–1329.

Morningstar, C., & Farmer, R. (1991). The lessons of Lucas-

film's Habitat. In M. Benedikt (Ed.), *CyberSpace: First steps* (pp. 273–302). Cambridge, MA: MIT Press.

Morton, G. (1980). Effect of eye contact and distance on the verbal reinforcement of attitude. *Journal of Social Psychology, 111,* 73–78.

Petty, R. E., & Cacioppo, J. T. (1984). The effects of involvement on responses to argument quantity and quality: Central and peripheral approaches to persuasion. *Journal of Personality and Social Psychology, 46,* 69–81.

Petty, R. E., & Cacioppo, J. T. (1986). *Communication and persuasion—Central and peripheral routes to attitude change.* New York: Springer-Verlag.

Sanchez-Vives, M. V., & Slater, M. (2005). From presence to consciousness through virtual reality. *Nature Reviews Neuroscience, 6,* 332–339.

Segrin, C. (1993). The effects of nonverbal behavior on outcomes of compliance gaining attempts. *Communication Studies, 44,* 169–187.

Slater, M., Usoh, M., & Steed, A. (1994). Depth of presence in virtual environments. *Presence: Teleoperators and Virtual Environments, 3*(2), 130–144.

Walther, J., & Burgoon, J. K. (1992). Relational communication in computer-mediated interaction. *Human Communication Research, 19,* 50–88.

Walther, J. B. (1996). Computer mediated communication: Impersonal, interpersonal, and hyperpersonal interaction. *Communication Research, 23,* 3–43.

Witmer, B. G., & Singer, M. J. (1998). Measuring presence in virtual environments: A presence questionnaire. *Presence: Teleoperators and Virtual Environments, 7*(3), 225–240.

Yee, N., Bailenson, J. N., Urbanek, M., Chang, F., & Merget, D. (2007). The unbearable likeness of being digital—The persistence of nonverbal social norms in online virtual environments. *Cyberpsychology and Behavior, 10,* 115–121.

Appendix A: Global Warming Questionnaire

(*Note that this questionnaire was administered in another language and translated here for completeness, shown in Table A1.*)

The following questions relate to your opinion regarding the public issue of global warming. Please answer the questions by marking one of the numbers on the right of each question, 1 being the lowest and 7 being the highest.

Table A1. *Global Warming Questionnaire*

	Low			Average			High
1. How would you rate your actual knowledge in this issue?	1	2	3	4	5	6	7
2. What is your level of awareness?	1	2	3	4	5	6	7
3. What is the degree of your concern?	1	2	3	4	5	6	7
4. What is the level of perceived risk this issue poses on your life?	1	2	3	4	5	6	7
5. What is your willingness to pay or sacrifice to better cope with global warming?	1	2	3	4	5	6	7
6. To what degree would you support general environmental goals?	1	2	3	4	5	6	7
7. To what degree do you think the local government should act in this area?	1	2	3	4	5	6	7