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Effects of Gesture-based Avatar-mediated Communication on Brainstorming and Negotiation Tasks Among Younger Users

Abstract

This paper reports on a study which investigated the effects of gesture-based avatar-mediated communication on younger users (12-13 years old), in comparison to video-mediated communication. Specifically, we looked at how these technologies were used by school pupils to brainstorm and negotiate ideas in a bullying context. 64 school pupils were divided into two conditions (Skype and AvatarKinect) and were instructed to carry out two tasks (a brainstorming and a negotiation task). Objective task performance, perceived satisfaction and perceived partner's characteristics were compared. We found no difference in term of perceived satisfaction. AvatarKinect users reported more positive changes in perceptions toward their partner. The results on task performance were ambivalent; Skype users seemed to generate more ideas, whilst AvatarKinect produced better quality ideas. In summary, gesture-based avatar technology appears to be a useful modality to help resolve bullying in schools.

Keywords: avatar-mediated communication, video-mediated communication, gesture-based, younger users

1. Introduction

The potential of technology to connect people and mediate people's interaction via computer interface is an ongoing concern of computer-mediated communication (CMC) studies. Traditionally, CMC facilitates interaction mainly through the medium of text and audio (Olaniran 2002). With the advances in technology, video-based and 3D virtual environments are getting increasingly common (McIntyre & Feiner, 1996). 3D virtual environments are particularly interesting as social interactions is usually mediated by an avatar, a computer generated visual representation of the user. Both video and avatar-based CMC attempts to overcome a fundamental issue of traditional text or audio-based CMC – the lack of social cues (Lea & Spears 1992, Garrison et al 2000, Vrasidas & McIsaac 2000). Recently, we have witnessed the emergence of new CMC technologies incorporating natural user interaction approaches such as gesture-based interfaces and facial recognition into avatar technology.

While the benefits and drawbacks of text and voice-mediated communication are fairly well explored (see Bordia 1997), the communication potential of newer interaction modalities such as real time video, avatar-augmented and gesture-based interfaces are less well understood due to their fairly recent: a) emergence (avatar and gesture interfaces), and b) widespread adoption (real time video).

Therefore, the aim of the study is to find out how two different technological modalities, i.e. video-based and gesture-based avatar-mediated communication can facilitate brainstorming and negotiation tasks in the context of bullying in school. The specific objectives of the study are:
   a) to study gesture-based avatar-mediated communication in comparison to video-mediated communication;

b) to provide some indications on how effective gesture-based avatar technologies are in the context of bullying among young people;

c) to obtain some indications of design factors which are important for both types of communication.

2 Literature review

Most studies of CMC are of comparative nature focusing on the differences, advantages and disadvantages of CMC modalities as opposed to face-to-face (FtF) communication. Various theories, such as theory of social presence (Short, Williams & Christie, 1976) and media richness theory (Daft & Lengel 1986) provide important conceptual frameworks with which to analyse characteristics of each CMC modality in respect of their sociability potential, task completion and ability to transfer information. From the media richness theory point of view, text-based CMC (e.g. email, asynchronous messaging) is perceived as being less "rich", lacking in contextual and paralinguistic cues (Sproull, L., & Kiesler, S. 1986, Lea & Spears 1992, Garrison et al 2000, Vrasidas & McIsaac, 2000, Olaniran 2002), immediate feedback (An and Frick, 2006) as well as being poor in conveying the nuances and complexities of social and cultural dimensions of communication (O'Dowd 2004, Olaniran et al 2010, Herring 1996, Whittaker & O'Connail 1997, Mitra 2002). Social presence, likewise, impacts online interaction; the leaner the medium, it is claimed, the less friendly and personal communication (Rice & Love 1987).

Bordia (1997) analysed 18 experimental studies comparing FtF with different modalities of CMC. The comparison looked at differences in-group performance including idea generation, member participation, task completion and group dynamics. He concluded that CMC was generally more effective for idea generation tasks and completion of time-limited tasks. Individual member performance was also better in CMC, with evidence showing more equal participation due to the lower social pressure compared with FtF. However, CMC was less effective in understanding both the partner and the task involved while groups working with CMC displayed uninhibited behaviour resulting from an induced state of de-individuation (Bordia 1997). Kiesler, et al. (1984) explored the effect of text-based CMC on group interaction and decisions. Their findings indicate that CMC had noticeable effect on participation, interpersonal behaviour, decision making and efficiency. Compared with FtF communication, text-based CMC offers higher levels of self-disclosure due to the lack of auditory and non-verbal cues (Schouten, et al 2009), however it is less effective in building trust (Bos, et al. 2002). As Rice Hiltz and Spencer (2005) point out 'a medium may not only be "too lean" for particular tasks, but also "too rich" for others'.

As we move from text-based CMC to synchronous audio and video-mediated communication, different considerations arise. Halliday (1986) points out that the two modalities "impose different grid on experience" with audio and video adding additional "richer" layers of interaction. Although both audio and video interactions carry more social cues than text (Gunawardena & Zittle 1997, McIsaac & Gunawardena 1996, Hackman & Walker 1990), they are nevertheless both "dynamic and transitory", lacking fixed static record of interaction which is provided by text-based communication.

Ramsay, et al. (1996) found that users were keen to use different forms of media coupling in informal communication rather than relying on time-based media alone.

Early studies into video-mediated communication (VMC) found no substantial benefits of using VMC compared with audio (Ochsman & Chapanis 1974), although audio-mediated communication was found to improve task performance and perceived affordances (Ochsman & Chapanis 1974) as well as learners' affective side and output (Yamada 2008). Stephenson, et al. (1976) compared the content of dyadic interaction in voice only and FtF. Voice interaction was more task-oriented and impersonal compared with FtF. Chapanis (1975) found that the voice-mediated communication by itself was inferior to FtF lacking in richness and variety while the average amount of time to perform a task was only a little bit longer than FtF.

A study by O'Malley et al (1996) found that VMC was more effective compared with voice-mediated communication in task performance as subjects could see each other's faces, thus needed to say less. Boyle, Anderson & Newlands (1994) also found that visibility of conversational partner makes the information transfer and the turn taking more effective in a conversational problem solving task. Other research findings did not support these conclusions. Morley and Stephenson (1970) compared negotiation tasks across three modalities: FtF, video/audio and speech only. They found that audio-mediated communication was much more task-oriented, while participants in video and FtF interactions were more likely to compromise due to the presence of interpersonal information. Although in some cases VMC can be used as a substitute for informal FtF interactions, in itself it cannot replicate the richness and diversity of FtF (Wilbur & Ing 1996).

2.1 Avatar-mediated communication

One of the more recent technologies in CMC is avatar-based. Avatar is a computer generated graphic image which represents users in online interactions. Since its inception, avatar technologies have become increasingly popular, and this has spurred renewed research interests in CMC surrounding this technology. Some research themes include the effect of avatar appearance (Garau et al 2003, Bailenson & Yee 2007, Nowak & Rauh 2006), communicative realism (Bailenson, et al. 2003, Von der Pütten, et al. 2010), emotional engagement (Taylor 2011) and transmission of social cues (Walther 1996). Garau et al. (2003) investigated the impact of avatar appearance on the perceived quality of communication in a virtual world. The study found that the higher the realistic quality of the avatar appearance, the better perceived quality of communication. A study by Bente, et al. (2008) investigated the influence of avatars on social presence, trust between participants, non-verbal behaviour and perceived quality of interaction. They found that there were no substantial differences between video and avatar modalities in terms of observable behaviour and participants' experience.

In a study comparing text, audio, video and avatar communication found that video and avatar did not differ in relation to social presence, trust and user satisfaction when compared with voice. The differences between video and avatar mediated communication have been summarised by Bente and Krämer (2011) as follows: a) avatars have freedom of movement in a shared space which might also have an impact

on virtual objects, b) users can remain anonymous without disclosing personal information such as appearance or gender, and c) behavioural data rather than pixels guide the transmission of nonverbal cues. Overall, it seems that avatar-based communication studies offer a "disintegrated picture of the research field" (Bente & Krämer 2011). This is largely due to the fact that existing avatar technologies are very different and therefore difficult to compare.

2.2 Study of younger users and CMC
Research into the adoption of CMC by young people (e.g. adolescents) focuses primarily on text-based internet communication (instant messaging and chat) which is used to chat about ordinary topics, share intimate details about friends, gossip, as well as maintain relationships with circles of offline friends (Gross 2004).

A study by Valkenburg and Peter (2007) investigated Dutch online communication of teenagers between the age of 10 and 17 years. They found that there was a positive relationship between online communication and time adolescents spent online and the quality of their friendship which resulted in adolescents' improved sense of well-being. Self-disclosure online was studied by Schouten, et al. (2007) who found that adolescents were more likely to self-disclose online because the perception of fewer nonverbal cues led to them feeling more disinhibited. They also discovered that participants who were socially anxious thought that the Internet offered more value for intimate disclosure than those who did not have a socially anxious nature (Valkenburg & Peter 2007). Similarly, a study into Israeli adolescents behaviour online conducted by Mesch (2003) found that more socially isolated adolescents are more likely to be frequent Internet users. In general, research into the use of avatar technology has so far been focused predominantly on adult users.

3. Methodology
In this study, we aimed to study the use of avatar and video-mediated communication among younger users. An experiment was conducted with 68 secondary school students (aged 12-13) from three schools in Kent, England (22 from St Anselm's Roman Catholic School, Canterbury, 22 from the Archbishop's School, Canterbury and 24 from Borden School in Sittingbourne). The participants were recruited on a voluntary basis. Data from four participants had to be discarded (two from St Anselm's and two from the Archbishop's) because of technical issue with the data, leaving us with a total of 64 participants for the final analysis. The participants were paired up and asked to use one of the two communication modalities to carry out two tasks (a brainstorming task and a negotiation task) related to a hypothetical bullying scenario. In each session, the paired participants were asked to use either the Skype video chat program or Microsoft AvatarKinect[1], a communication program where user interactions are captured by the Kinect motion sensor and shown as gestures through avatars to carry out the two tasks. 32 participants used Skype and 32 used AvatarKinect.

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[1] http://www.xbox.com/en-GB/Kinect/KinectAvatars

Figure 1: A screenshot of the two programs used in the study, Avatar Kinect (Left) and Skype video chat (Right)

3.1 Experiment setup and procedures

The pair of participants either used Skype or AvatarKinect to carry out the brainstorming and negotiation tasks. The participants were situated in two separate rooms in each school. For the Skype condition, each participant in the pair was using the video chat function (see figure 1) while wearing a headset to carry out the task. For the AvatarKinect condition, there were several options as to how the avatars were presented on screen. We chose the option that resembled Skype's screen layout (figure 1). The participants were also wearing a headset for the AvatarKinect condition.

Prior to the experiment, the participants were introduced to the researchers (two co-authors of the paper were involved in the facilitation of the experiment), briefed on the purpose and the procedure of the experiment. Informed consent was obtained from their parents through the school before the study commenced. Participants were given an opportunity to ask any questions, particularly regarding any unfamiliar terminology. Then, the participants were asked to fill in a simple questionnaire regarding their basic demographics (age, gender, etc.) and their computer experience. The researchers reassured the participants that they could ask any question about anything in the study they did not understand. After that, they were given an opportunity to get used to the equipment by asking their partner three simple questions. Once they became familiar with it, a written hypothetical bullying scenario (see appendix A) was handed to the participants to read. Once again, they were encouraged to ask questions to clarify any doubt they had.

Each pair was given 10 minutes to complete the first task (brainstorming), and this was then followed by a 20 minutes negotiation task. In the first task, participants were asked to discuss ideas with each other to come up with as many solutions as they could to resolve the bullying scenario presented to them. All participants were given 10 minutes to come up with the solutions. In the second task, participants were given a list of possible actions, which could be taken to resolve the bullying situation. They were asked to both agree on a ranking of the preferred actions (which action is best, second best, and so on). In order to create a conflict of interest, each participant in the pair was given a different priority on the choices of actions. They were asked to try to negotiate with their partner so that their priority choices would end up high on the final ranking. Participants were given 20 minutes for task 2 but they were allowed to terminate the task earlier if they had already come up with an agreement before 20 minutes expired.

After completing the tasks, participants were given a questionnaire to evaluate their communication experience (see appendix B).

3.2 Measures and hypotheses

Perceived satisfaction

Likert scale questions were used to measure the perceived satisfaction in carrying out the task. Perceived performance satisfaction was measured by satisfaction in the decision process, while perceived outcome satisfaction measured the satisfaction of the outcome (Suh, 1999). (see appendix B)

Perception of partner

The perception of their partner was evaluated by three criteria, namely likeability, trustworthiness and level of intelligence (Jensen, Farnham, Drucker, & Kollock, 2000). The perception of partner was measured twice, once during the pre-questionnaire and once after the completion of both tasks. (see appendix B)

Reduced social cues theory (Kiesler et al 1984) maintains that "the lack of cues undermines the perception of leadership, status and power and leads to reduced impact of social norms ". In the context of the negotiation task in which power and conflict is inevitable, having an avatar-based representation of self may improve the user's perception towards their partner, thus the overall satisfaction of the tasks. Therefore, we hypothesised that:

- The outcome and performance satisfaction would be perceived to be higher by participants in AvatarKinect condition.
- The perception of partner's likeability, trustworthiness and level of intelligence would be higher in AvatarKinect condition.

Objective performance measures

The objective measures of performance in both tasks were the "compromise score" received for the negotiation as well as the quality and quantity of the ideas for the decision task (Hung, Huang, Yen, & Chang, 2007). For the first brainstorming task, two experts on bullying at Project Salus (an organisation which provides innovative services to children and young people in Kent, England) rated the ideas generated by all participants.

For the second task (negotiation task), a method similar to Suh (1999) was used to calculate the "compromise score" in which each participant was given points according to whether their preferred choice ranked high in the final list. Specifically, it was calculated by summing the differences between the agreed rank order and the rank order given to each participant. We inversed the summed score so that higher scores reflected better compromise.

According to Daft and Lengel's (1986) media richness theory, media richness is a function of a) the medium's capacity for immediate feedback, b) the number of cues and channels available, c) language variety; and d) the degree to which intent is focused on the recipient. The greater social presence of a medium creates a greater immediacy of the communication, because of the greater number of channels. Therefore, video-based communication should be able to convey more information than the avatar-based technology, thus resulting in better task performance. Therefore, we hypothesised that:

- Participants using Skype would produce more ideas in the brainstorming task than the AvatarKinect condition.
- Participants using Skype would produce higher quality ideas in the brainstorming task than the AvatarKinect condition.

- Participants would compromise better in the negotiation task in the Skype condition.

Other variables in this study included the computer experience, level of acquaintance of the pair and gender. All questionnaire measures (perceived satisfaction and perception of partner) achieved a good level of reliability:

Table 1: Reliability test

Measures	Cronbach's α
Outcome Satisfaction	0.835
Performance Satisfaction	0.778
Likability Satisfaction	0.890
Trustworthy Satisfaction	0.852

* Note that level of intelligence was measured with only one item (Jensen, Farnham, Drucker, & Kollock, 2000).

Results

38 participants were 12 years old, and 25 participants were 13 years old at the time of the study (one participant did not specify age). In terms of gender distribution, 67.2% were male and 32.8% were female. The participants reported having high experiences with computer usage. Of the maximum score of 10, participants reported a mean score of 6.31 (SD=2.167) for 3D computer games, 4.91(SD=1.875) for email, and 4.31(SD=1.851) for voice chat (see figure 2). We also recorded the level of acquaintance between the two participants in the pair. The mean score of acquaintance (out of 5) was 2.86 (with SD=1.125).
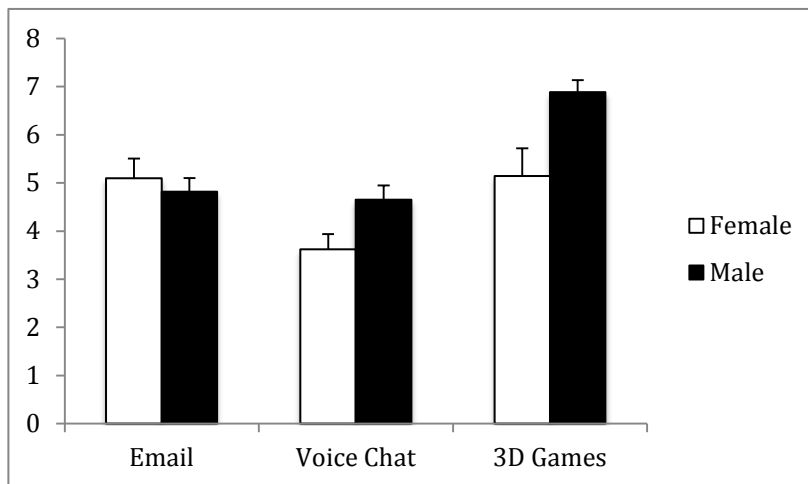

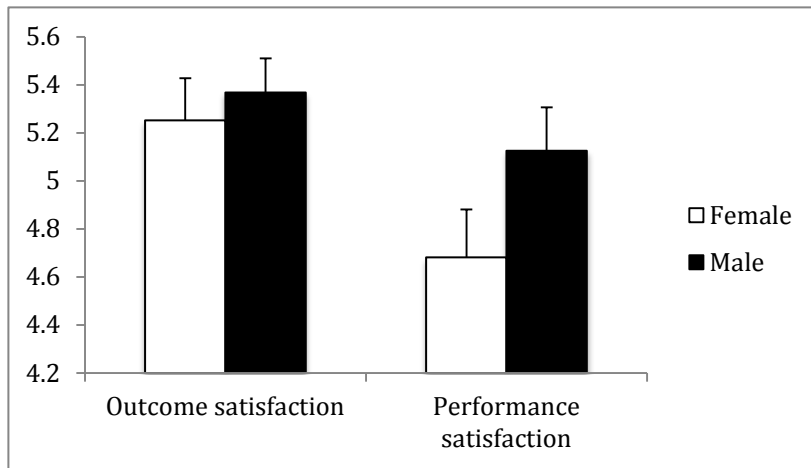Figure 2: Experience with various computer technologies (by gender)

Figure 3: Perceived outcome and performance satisfaction (by gender)

Figure 3 shows overall perceived outcome and performance and satisfaction scores based on gender. The mean score for outcome satisfaction was 5.25 (SD=0.804) for female, and 5.37(DS=0.933) for male. The mean score for performance satisfaction was 4.68 (SD=0.916) for female, and 5.13(SD=1.189) for male.
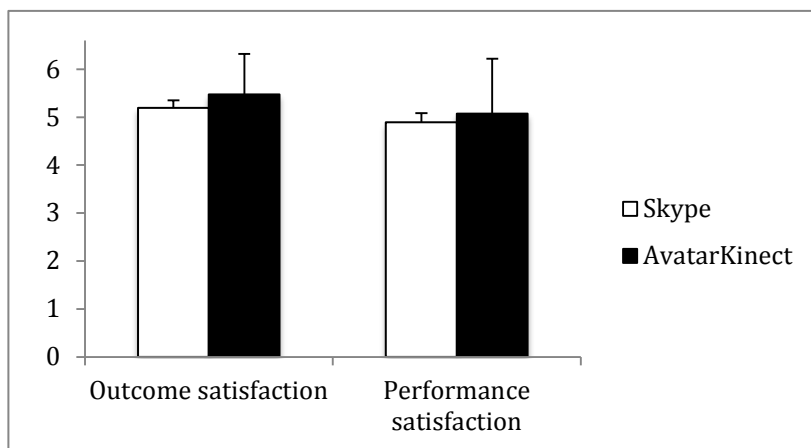
Figure 4: Perceived outcome and performance satisfaction (by modality)

Examining the mean score, participants rated the outcome satisfaction of AvatarKinect (mean = 5.47, SD=0.845) as being slightly higher than Skype (mean=5.19, SD=0.920). Similarly, the performance satisfaction of participants using AvatarKinect (mean=5.07, SD=1.146) was higher than Skype (mean=4.89, SD=1.102) (figure 4). However, no statistical significance was detected for either outcome satisfaction, t(62)=-1.288, p=0.203, or performance satisfaction, t(62)=-0.656, p=0.514.

Figure 5: Perceived change in partner's likeability, trust and intelligence before and after study (by modality)

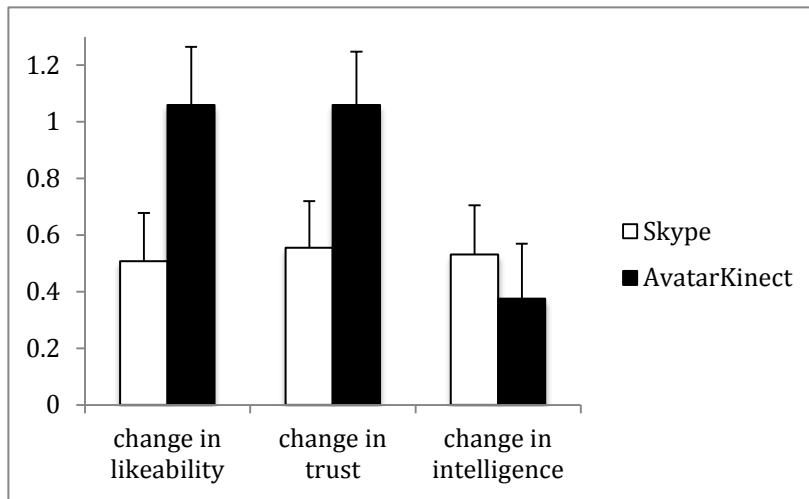Figure 5 showed the change in likability, trust and intelligence scores before and after the study for both modalities. A positive change indicates that participants perceived their partner to be more likeable (or trustworthy, intelligent) after the study. Note that the changes were all positive for both modalities. T-tests showed that participants using AvatarKinect reported a more significant positive change in the likability ($t(62)=-2.065$, $p<0.05$) and trustworthiness ($t(62)=-2.496$, $p<0.05$) than Skype users. However, no significant difference was observed for change in intelligence, $t(62)=0.599$, $p=0.551$.
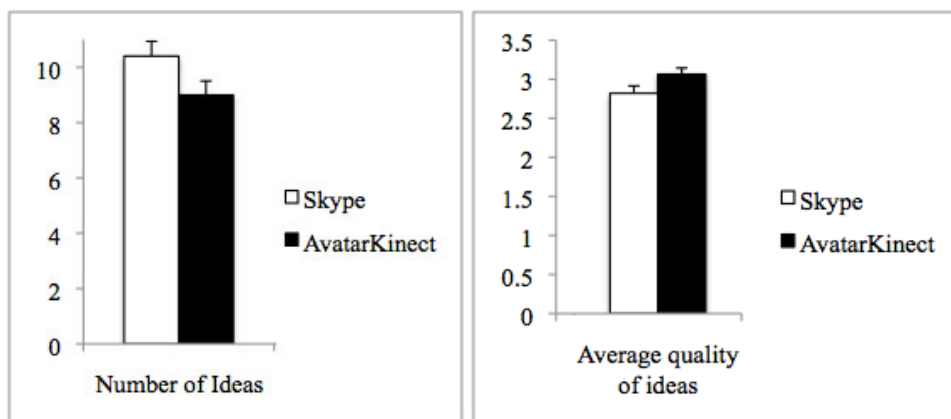
Figure 6: Number of ideas and quality of ideas by modalities (task 1)
* note that 1 participant was excluded from the analysis for task 1 because of missing data

Analysing the outcome of task 1, it was observed that participants using Skype generated more ideas (mean= 10.406, SD=3.057) than AvatarKinect (mean=9.000, SD=2.817). This was however borderline significant, $t(61)=-1.897$, $p=0.063$. In term of the quality of ideas as rated by two experts in bullying, AvatarKinect users produced higher quality ideas (mean=3.065, SD=0.440) than Skype users (mean=2.820, SD=0.540). The difference was almost significant at the 0.05 alpha level, $t(61)=-1.975$, $p=0.053$. In such borderline cases, we referred to the confident interval of mean

differences (Hackshaw & Kirkwood 2011). For the number of ideas, the mean difference was 1.406 (95% confidence interval -0.076 to2.888), whilst for the quality of ideas, the mean difference was -0.245 (95% confidence interval -0.494 to 0.003). There was only a 2.8% percentage of chance that mean difference of number of ideas was lower than zero (no difference), and 2.3% percentage of chance that mean difference of quality of ideas was higher than zero (no difference). Therefore, it seemed likely that Skype users generated more ideas, and AvatarKinect users produced better quality ideas.

We also investigated how well the pair reached compromise in task 2. Recall that in task 2, participants were tasked to agree on a ranking of the preferred actions for a hypothetical bullying scenario, from a given list of actions. The "compromise score" was calculated by summing the differences between the agreed rank order and the rank order given to each participant. We inversed the summed score so that higher scores reflected better compromise.

Figure 7 shows that participants in the Skype condition appeared to have slightly higher "compromise score" than AvatarKinect participants (Skype, mean=19.133, SD=9.568; AvatarKinect, mean=17.733, SD=8.258). However, this observation was not statistically significant, $t(58)=0.610$, $p=0.544$.
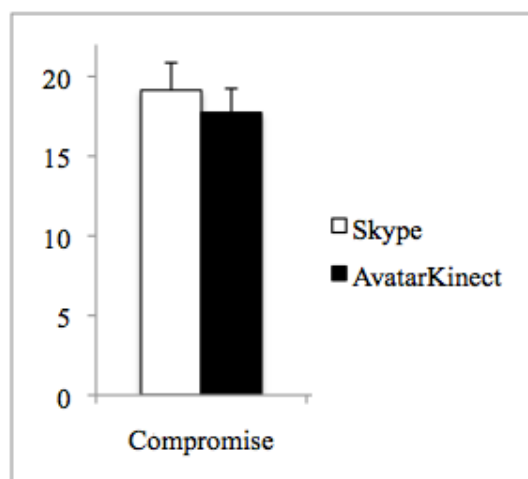
Figure 7: Compromise score by modalities (task 2)

Factors predicting outcome and performance satisfaction
In order to identify the factors predicting the outcome and performance satisfaction for both AvatarKinect and Skype, we carried out stepwise regression with the following independent variables: level of acquaintance, experience in email, voice chat and 3D game, as well as post-study likeability, trustworthiness and intelligence scores.

Stepwise regression on outcome satisfaction with AvatarKinect showed that post intelligence score (B=0.594, SE=0.608, $p<0.001$) and 3D games experience (B=0.296, SE=0.245, $p<0.05$) were the main predictors of outcome satisfaction ($R^2=0.528$, $p<0.001$). For the Skype condition, we found that that post trustworthiness score (B=0.683, SE=0.561, $p<0.001$) was the key predictor of outcome satisfaction ($R^2=0.466$, $p<0.001$). Stepwise regression on performance satisfaction with AvatarKinect showed that post intelligence score (B=0.436, SE=1.028, $p<0.05$) was the main predictor of

performance satisfaction (R^2=0.190, p<0.05). As for the Skype condition, post trustworthiness score (B=0.464, SE=0.815, p<0.01) was the main predictor of performance satisfaction (R^2=0.215, p<0.01).

Post study scores were included in the analysis because we wanted to gain some understanding on how different features of the modalities could improve user satisfaction.
As a conclusion, we found that to improve both outcome and performance satisfaction for Skype, it is important for the users to perceive their partner as being trustworthy. For AvatarKinect users however, the perception of their partner's intelligence was a key factor.

Discussion
In this study, we compared the user perception and task performance during synchronous dyadic interaction in video (Skype) and avatar-mediated (AvatarKinect) communication settings. We found that participants liked and trusted their partner significantly more in the AvatarKinect condition.

Compared to Skype, AvatarKinect has a lower level of social cues. This results in reduced perception of status, power and social norms. The hyperpersonal CMC model (Walther, 1996) also implies that interface characteristics of certain CMC offer a way for users to optimise their self-presentation to overcome negative expectation and to enhance their relational outcomes (Walter et al 2011). For instance, Cheng et al. (2002) found that users in fact preferred self-representations which were "neither too true-to-life to their own appearance nor too abstract". Studies in self-disclosure further supported this notion. Self-disclosure serves to increase mutual understanding and builds trust by making the discloser increasingly vulnerable (emotionally or otherwise) to the other person. For instance, Bailenson et al. (2006) demonstrated that both verbal and non-verbal self-disclosure were lowest in videoconference, compared to voice-only and abstract-avatar communications (Bailenson et al. 2006). A meta-analysis of studies on self-disclosure has also found that self-disclosure was higher in computer-administered interview than in face-to-face settings, suggesting that less realistic self-representation would elicit more self-disclosure. Furthermore, it has been demonstrated that in some cases, "behavioral realism" (how the avatar mimics the non-verbal behaviour such as gestures and eye gaze) was more important than "form realism" (how visually realistic the avatar is) (Bailenson and Beall 2005).

Therefore, AvatarKinect, which combines lower "form realism" and high "behavioural realism" (through gesture and facial tracking) would lead to higher perception of trust and likeability. Perhaps due to the nature of the task (negotiation) where disagreements were to be expected, having a playful avatar representation helped increase the likability and trustworthiness. Indeed, this result in likeability is in line with previous studies (Nowak, 2004) looking into how virtual images influence judgement about the partner. It was found that less human-like image was perceived to be more likeable than "no image" communication. Interestingly, "no image" was perceived to be more likeable than human-like image. Similar results were found for trustworthiness. However, our study did not identify statistical significance for the perception of intelligence.

Although the perception towards their partner improved, overall satisfaction of the participants in AvatarKinect condition was not significantly higher than Skype users. Studies in avatar-mediated communication (Vilhjálmsson 2004) showed that the use of avatar resulted in users feeling that the task was less difficult. Furthermore, it has been shown that the use of avatar sales agent led to higher satisfaction with the seller and more positive attitudes towards the product (Holzwarth et al., 2006). Yee et al (2007) conducted a meta-analysis of the impact of avatar realism by reviewing 46 studies in avatar-mediated communication. The analysis showed that the presence of avatar representation led to more positive social interaction, compared to CMC with no representation (e.g. some text or voice based systems). It has also found that human-like representations with higher realism resulted in more positive social interaction. However, the hypothesis of the "Uncanny Valley" in robotics literature states that avatars/robots with too high a degree of realism evokes unpleasant feelings in the users (Mori 1970). Indeed, cartoon-liked avatars have been used successfully in peer communication (Persson 2003). The result of the current study did not seem to support these past studies which dealt predominantly with adult users. This calls for further studies in this area for different age groups, as studies have indeed showed that technological use pattern is different depending on age groups (Pfeil et al 2009).

There is a large literature of work examining several modes of communication and their effects on task performance. Particularly, it has been shown that the use of video had little advantage over audio-only communication on task performance (Olson, et al 1995; O'Malley et al 1996), although Short et al (1976) showed that in negotiation tasks, video did show improvement in task performance. Newer studies (Vilhjálmsson 2003) found that avatar technology did not improve the performance in a task of explaining a map to each other, compared to no-avatar condition. The present study on avatar and video-mediated communication showed ambivalent results.
In task 1, AvatarKinect users generated better quality ideas compared to Skype users, while more ideas were generated by Skype users. Although both results were borderline significant, further examination on the confident interval suggested that it is worth investigating this issue with larger sample size in the future. As for task 2, we found that both participants in AvatarKinect compromised with each other equally well.

Finally, the study also highlighted interesting results which may have important implications on design. The perception of partner's trustworthiness was an important factor to improve outcome and performance satisfaction in video-mediated communication, whereas for avatar-mediated communication, the key factor was partner's intelligence. The trustworthiness of the source is very important in communication and people are more likely to accept a message if they trust source (Hovland et al., 1953). However, it is not apparent to us as to why trustworthiness was an important predictor in Skype but not AvatarKinect.

Conclusions
The study showed the potential of employing gesture-based avatar technologies in the school context, in the context of brainstorming and negotiation among students. It has been generally believed that avatar-mediated communication is somewhat poorer in term of the emotional and gesture richness, compared to video-mediated

communication. Newer technologies such as AvatarKinect implemented avatars that respond to emotional and gesture cues, thus making the social interaction potentially more satisfying. In addition, as people (especially younger people) are growing up with avatar-augmented and gesture-based CMC technology, they are becoming more comfortable with this form of communication. Our study provided an indication of how this technology could be useful in mediating conflict relating to bullying situations in the school context. However, larger scale studies need to be carried out to examine more closely how other attributes such as gender and socio-economic backgrounds might influence the outcomes. Although compared to non-gesture-based avatar systems AvatarKinect has relatively high behavioural realism, the gesture recognition technology is still generally crude and does not detect certain features, for instance fingers. It des not detect facial expression accurately either. Therefore, future studies could focus on avatars with higher degrees of behavioural realism. Visual realism is another area that is worth investigating. As aforementioned, several studies have focused on the photo-realism of static avatar (still images). Future research could focus on visual realism in a gesture-based setting.

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Appendix A. Bullying scenario

There are a few people left in the locker room after gym class. The bully walks around the corner behind his victim and aggressively bumps into him.
Victim: "Why can't you just leave me alone? What do I have to do?"
Bully: "You can piss off and die."
Victim: "Well, that's not going to happen. Do I really have to get my parents and the headmaster involved?"
Bully: "You do and you're dead!" (Bully shoves the victim and leaves)
Victim: Says nothing. Packs up looking upset and worried about what has happened.

Appendix B. Questionnaires

Outcome satisfaction

1 How satisfied or dissatisfied are you with the quality of the solution (or outcome of the whole exercise) which you and your partner reached?								
Very dissatisfied	1	2	3	4	5	6	7	Very Satisfied

2. To what extent does the final solution (or outcome) show your own input?								
Not at all	1	2	3	4	5	6	7	Very much

3. To what extent do you feel committed to the solution (or outcome)?								
Not at all	1	2	3	4	5	6	7	Very much

4. To what extent are you confident with the solution (or outcome) is optimal (the best it can be)?								
Not at all	1	2	3	4	5	6	7	very well

5. To what extent do you feel personally responsible for the solution (or outcome) which you and your partner reached?								
Not at all	1	2	3	4	5	6	7	very well

Performance satisfaction

Overall, How will you describe the process of discussion that you and your partner (the other student doing the study) used?								
Efficient	1	2	3	4	5	6	7	Inefficient
Uncoordinated	1	2	3	4	5	6	7	Coordinated
Fair	1	2	3	4	5	6	7	Unfair
Understandable	1	2	3	4	5	6	7	Confusing
Dissatisfying	1	2	3	4	5	6	7	Satisfying

Perceived partner characteristics

How would you describe your partner during the conversation through (AvatarKinect/ Skype)								
Not Likable	1	2	3	4	5	6	7	Likable
Unkind	1	2	3	4	5	6	7	Kind
Unfriendly	1	2	3	4	5	6	7	Friendly
Cold	1	2	3	4	5	6	7	Warm
Not Honest	1	2	3	4	5	6	7	Honest
Unfair	1	2	3	4	5	6	7	Fair
Untrustworthy	1	2	3	4	5	6	7	Trustworthy
Not Sincere	1	2	3	4	5	6	7	Sincere
Not intelligent	1	2	3	4	5	6	7	Intelligent