Gender Differences in Gesture-based Interaction

User Studies and Perception of Information Technology

Manolya Kavakli Yan Ling Chen
Department of Computing
Macquarie University
Sydney, Australia
Manolya.Kavakli@mq.edu.au

***Abstract*— This paper presents an empirical study investigating the gender differences in basic hand gestures for the design of user-centric and adaptive systems. Our goal is to target personalization of gesture-based interaction, devices and applications, using this feedback. First, we focus on gender differences in the perception of technology as well as the externalization of thoughts using natural hand gestures. We commence with an overview of what type of gestures are used and how they are defined in a gesture recognition system. In the empirical studies, we use both video analysis and surveys as the methodologies. We conducted a survey regarding the perception of Information Technology (IT) with 20 male and 20 female participants. Second, we focus on gender differences in gestures. We conducted an experiment involving 10 male and 10 female Australian adults whose age range between 25 to 30. In the experiment, they describe an object using hand gestures and speech. We analysed the results of both survey and experiments. In this paper, we point out the gender differences in the perception of IT, as well as gesture types, frequency and occurrences. Drawing conclusions from these comparisons, we discuss the potential effects of gender differences in the design of multimodal interfaces.**

Keywords-gesture analysis; gender differences; human computer interaction; consumer research; perception of technology.

I. INTRODUCTION

Human Computer Interaction (HCI) is a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use. One of the primary goals of HCI is to target the design of user-centric and adaptive systems as well as personalization of devices and applications. Adaptive systems refer to interactive systems adapting their behavior to individual users based on information acquired about users, the context of use and the environment. Therefore, personalization of devices and applications requires a careful analysis of gender differences.

The evolution of HCI has evolved significantly starting from the use of mouse input [1] to multimodal systems including speech, head and eye-tracking, using both static and dynamic hand gestures. Gestures are considered as sign languages to externalize the human thoughts. Humans have an inherent need to use gestures; they complement our ideas. To such an extent that humans are known to gesture even when on the phone. The level of communication between users and their electronic devices has been largely limited to a pointing interface. As computers and technologies become increasingly integrated into our lives, the demand of technology has increased and expanding into new sectors, as seen with the new apps and wider use of the smart phones and tablets. This brings the emphasis on the richness conveyed by gestures as the new media of interaction. Computer vision techniques have improved exponentially: from only detecting simple features like the user's fingers and thumb, to recognizing and responding to the whole body contour, since the first VideoDesk [2]. Hand posture detection has been used to give commands, and hand rotation and movement to indicate the parameters of these commands. Investigation of tangible and proximity based HCI suggested that it is important to be cognisant of gender with respect to the interactions they facilitate [3].

As shown by Nasser and Kavakli [4] culture has an impact on gestures, but does gender have an impact? The goal of this paper is to define the variances in gestures between males and females in order to develop personalized interfaces. Gender differences have been studied by many researchers, leaving much unclear regarding the science behind stereotypes. Our intention is to identify, if there are any gender differences in the perception of technology as well as hand gestures used to explain an object. We defined two hypotheses to test. (1) The experience of using a computer as well as the gender of the user has a significant effect on the perception of the gender of the technology. The objective of the survey in this study is to investigate this research question. (2) Gender differences in gestures have a significant influence on human performance.

The paper is structured as follows: Section II reviews summary of related works regarding gestures and gender differences. Section III describes the methodologies used in the project. Section IV addresses the survey and the experiment. Section V goes into finer details with respect to analysis of the data collected. Section VI presents the findings. The acknowledgement and conclusions close the article.

 ISBN: 978-1-61208-369-8

II. GENDER DIFFERENCES

Regarding the individual differences in cognitive processing, controversial views exist. Some studies state that there are gender differences in verbal, quantitative and visuo-spatial ability in human cognition [5]. A general view is that men outperform women on visuospatial tasks and women outperform men on verbal fluency. Males show significantly higher mean scores on the arithmetical computations, arithmetical reasoning, and spatial cognition [6]. However, some researchers believe that although there are gender differences in our cognitive abilities (verbal, quantitative, visuospatial) these are quite small, and therefore, insignificant [7]. How small are these gender differences in terms of gesture recognition in multimodal system design?

It was suggested by Kramer [8] that women more often use facial expression and hand gestures to express their thoughts than men. Regarding nonverbal communication, there are differences between females and males. Women use more expressions and nonverbal behaviors than men. Women are more skilled at sending and receiving nonverbal messages [9]. Men are louder and more interruptive and display more nervous, defluent behaviors. The differences in the mean use of hand gestures was statistically significant in a social bar setting [10].

Men are likely to use their hands to express themselves and they rely on more obvious gestures. Women, on the other hand, present more subtle gestures and they restrain and exhibit deferential gestures [11]. No specific studies address whether any gender differences present in use of gestures while people communicate with computer systems. Saucier and Elias [12] reveals that the number of gestures made with the right hand during speech is significantly higher for males, while during listening the number of gestures made with left hand is significantly higher. We have no results regarding the females left or right handed gestures. However some other studies state that their results did not reveal any differences in the degree of hand preference between pointing gestures produced along with speech and gestures produced on their own [13].

Studies on the perception of IT showed that although males and females in the United States have similar experiences with computers, females have an advantage in typing [14]. Workers in general state that they have more experience with computers than non-workers, and, in particular, working females have been using computers for more years than working men. Nonworking females state that they have less experience with computers than working females. However, this perception for the other gender is not verified and there seems to be no perceived difference in the use of computers between nonworking and working men.

A. Use of Internet

In USA, Internet use at various locations increased over time among women relative to men. In 1997 and 1998, women were less likely to use the Internet anywhere or at home than men, but they were more likely to do so by 2001 [15]. Among those who work, women remained less likely than men to use the Internet at work, but the gender gap narrowed over time. People who are employed are more likely than the non-employed to use the Internet at home or anywhere, else with nonworking women the least likely to use the Internet. This is also consistent with our findings in this paper.

B. Use of Social Networks

Tüfekçi [16] found significant differences between males and females on the usage of social networks that females are more likely to use social networks to keep in touch with friends either living nearby or in other schools, while males are more likely to use social networks to find potential friends and find people with have similar interests [17]. However, males tend to make new relationship in social network environments more than females do. On the other hand, Tüfekçi found that females' communication skills are more positive than males' and suggested that females are more social than males. Females state that they use social networks, such as Facebook for maintaining existing relationships, academic purposes and following agenda more than males, while males use facebook for making new relationships at a rate higher than females.

III. GESTURE CLASSIFICATION

The most recognized gesture classification and the one referred to from now on is the one established by McNeill in [18]. He classifies gestures as seen in Table 1. Gestures have also been classified according to their purpose. They could be goal-oriented (change of position, shape), indirect manipulation (set, stop), empty handed gestures (wave, snap, point, take), and haptic exploration (touch, stoke, knock).

A. Gesture Types

McNeill [1] identified the gestures types as summarized in Table I:

Iconic. Iconic gestures were identified as actual picturing, as if drawing. Therefore, if a participant mentioned the word "square" and drew a square, it was considered an iconic gesture.

Beat. Beat gestures were generated by context and marked a gesture or transition. A beat gesture was identified, for example, if a person described the back of a chair and stressed staying back and the hands were put a bit forwards. These were mainly low energy low kinetic gestures.

Repetition. Repetition gestures are part of beat gestures, but for the purpose of the experiment, they were counted separately.

Deictic. Deictic gestures correspond to pointing, but they do not include gestures performed purely with the index fingers. This pointing gestures are normally accompanied by words like "there" or "left" for example.

Metaphoric. Metaphoric gestures represent conceptual subjects. In the experiment they represent an abstract concept like "old" or "retro". A user would not use these as an actual depiction, but they may use them to supplement a word or enhance the meaning of another gesture..

Junk. Junk gestures were identified as gestures without a particular meaning. This could be a gesture that the user takes back (a "mistake") or some transition movements.

 ISBN: 978-1-61208-369-8

TABLE I. CLASSIFICATION OF GESTURE TYPES

Gesture	Function	Linguistic example
Iconic	Resembles that which is being talked about	Flapping arms like wings when talking about a bird
Metaphoric	Abstractly pictorial; loosely suggests that which is being talked about	Making a box shape with hands when talking about a room.
Beat	Gestures with only two phases (up/down, in/out) indexing the word or phrase it accompanies as being significant	Rhythmic arm movement used to add emphasis
Deictic	Gestures pointing to something or somebody either in concrete or abstract	Pointing while giving directions

B. *Gesture Segmentation*

The technique mostly used for gesture analysis is gesture and speech alignment. In practice, gestures are identified as atomic parts, or, as a sequence of hand shape [19] the latter being harder to measure. Normally the gesture coders are guided by the endpoint localization to perform the segmentation and recognition. The reality is that the spatio-temporal variation comes from the fact that not only do different people move in different ways, but also even repeated motions by the same subject may vary [20]. The issues here are speed and endpoints, making it challenging to know when a gesture ends and when another begins. Within different technologies, there are different methods for detecting a candidate cut. For example, in video games they are based on three criteria: abnormal velocity, a static gesture, and sever curvature [21]. Li and Greenspan [20] focus on how the endpoints are located. They had participants repeat various actions several times in order to document the variances, these variances, they claim, are useful for identifying the range of a given gesture, and therefore a better identification. This way, to build a gesture model, a gesture representation, repeated at a single moderate speed, does not have to be perfect.

IV. METHODOLOGY

This section covers the explanations of the methodologies we used in the project. In this section, we will have a discussion regarding the purpose and the advantage of each methodology.

A. *Survey*

The goal of the survey is to explore the gender differences in the perception of Information Technology (IT). This survey was carried out in the early stages of the project to help us understand the general perception of males and females regarding IT. 20 participants joined our survey the perception of IT. The age range of participants is 25-30 years old. They come from Asian and Australian backgrounds. They are either professional or university students. For the purpose of this survey, we collected the results from the participants based on 21 questions regarding their perception of using electronic devices in their daily lives as well as internet usage.

B. *Video Analysis*

We used the video annotation tool ANVIL [23] for video analysis. ANVIL offers multi-layered annotation based on a user-defined coding scheme (Figure 1). Special features offered by ANVIL are the tracks for time stamp, coding facilities on video footages and a project tool for managing a collection of annotation files. The gestures are separated by pauses. A pause is defined as a temporary stop in action or speech. The purpose of this pause is to eliminate the period of inactivity from the actual gesture time. This pause could appear at the beginning of a video, when the participant explains what he or she might do, or when the participant states that he or she has ended the action. ANVIL permits the creation of a track on the time line where gestures are segmented and coded.

Figure 1: ANVIL annotation track

C. *Experiments*

18 participants including 8 males and 10 females joined our experiment. The participants were divided into two groups. The participants were the ones who did the survey before the experiment. Their age range was 25-30 years old. They were either Australian or Asian. The participants were either employed or unemployed. We have chosen a group of males and females with English as their native language.

Firstly, we explained the task to the participants. They were asked to describe a particular object (Figure 2). We used a camera to record each participant. During the experiment, all participants were given the task to describe a chair, the participants were also instructed to describe the chair as if they were describing the object to someone who cannot see in a videoconferencing session. They were encouraged to use both hands and as many gestures as possible. All participants used words to accompany their gestures, even they were not instructed to do so.

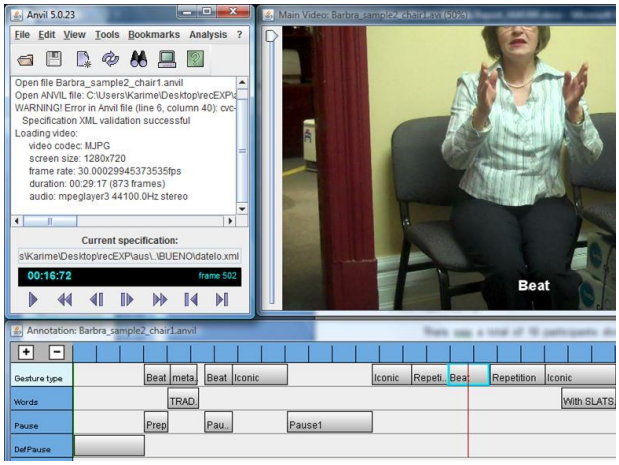

Figure 2: A snapshot from the experiments

D. Video Analysis

In video analysis, we used the gesture classification defined by McNeill [1] and Table I. We considered the gesture type Repetition, as a factor potentially reflecting the culture of the participant, as uncertainty in the language or description could be channelized this way using Hofstede's cultural dimensions [22].

V. RESULTS

This section covers the results of survey and experiments.

A. Survey Results and Demographics

The Analysing the survey, we found that all male participants perceive themselves as having more experience with computers than female participants. According to Table 2, 80% of male participants state that they have more than 10 years of experience in using IT, while the rest opts for 6-9 years. The trend is reverse in females with 86% stating that they have 6-9 years of experience in using IT and 13% with more than 10 years. According to Table 2, either male participants start using technological devices perhaps earlier than females or they consider themselves having higher level of computer experience than females.

TABLE II. PERCEIVED COMPUTER EXPERIENCE

experience of using computer	Male(%)	Female(%)
less than 3 years	0	0
3-6 years	0	0
6-9 years	0.2	0.86
more than 10 years	0.8	0.13

As seen in Table 3, most females consider themselves as beginners in computer use (92%), which indicates that they use computers at a basic level, such as internet browsing, typing etc. However, most males (92%) consider themselves as intermediate or professional users of computer.

.

TABLE III. PERCEIVED COMPUTER SKILLS

level of computer skill	Male (%)	Female (%)
Beginner	6	92
Intermediate	26	13
Professional	66	0

According to Table 4, 53.3% of males spend more than 6 hours on a computer each day; however none of the females opts for that. At most, 33.3% of females spend 4-6 hours on a computer each day. This daily experience of using computers seems to have a significant influence on the perception of IT. Perhaps, as a result of this, males feel more confident in using computers than females or at least they state that it is the case.

TABLE IV. TIME SPENT ON COMPUTER

Average time spend on computer each day	Male (%)	Female (%)
Less than 1 hour	0	0
1-3 hours	26.6	66.6
4-6 hours	20	33.3
More than 6 hours	53.3	0

More interestingly, we asked participants in the survey what the gender of their IT device is (i.e., desktop, mobile, laptop or tablet, and the internet) and compared the responses of females to males. Table 5 demonsrates the perceived gender of IT device overall including males and females. According to this table while desktop computers seem to be perceived as a more masculine technology (43.3%), mobile phones are perceived more feminine (50%). Laptops have no gender (68%), neither does the Internet (73%).

TABLE V. PERCEIVED GENDER OF IT DEVICE OVERALL

	Desktop (%)	Mobile Phone (%)	Laptop (%)	Internet (%)
Masculine	43.3	6.6	8	10
Neutral	33.3	43.3	68	73
Feminine	23.3	50	24	16

However, when comparisons are drawn between males and females as in Table 6 and Table 7, we found that there are gender differences in the perception of the gender of technology. We found that all male participants consider the internet with no gender at all. Majority of males think that their IT device has no gender. Still, if there is a gender associated with it, desktop is masculine (40%), mobile phone (20%) and laptop are feminine technologies (14.2%).

TABLE VI. PERCEIVED GENDER OF IT DEVICE BY MALES

men	Desktop (%)	Mobile Phone (%)	Laptop (%)	Internet (%)
Masculine	40	13.3	7.1	0
Neutral	53.3	66.6	78	100
Feminine	6.6	20	14.2	0

More than 86.6% of females think that their desktop has a gender (while more than half of these think that their desktop is masculine, the other half think that it is feminine). Their perception of mobile technology is primarily feminine (80%), but their laptop (36.3%) and Internet (33.3%) are partially feminine, while majority of them think that their laptop and internet has no gender .

TABLE VII. PERCEIVED GENDER OF IT DEVICE BY FEMALES

women	Desktop (%)	Mobile Phone (%)	Laptop (%)	Internet (%)
Masculine	46.6	0	9	20
Neutral	13.3	20	54.5	46.6
Feminine	40	80	36.3	33.3

These findings imply that while males show a tendency to objectify the technology, they do not seem to see the personality or gender behind their IT device. For them, an IT device is an object and nothing more than that, whereas a large proportion of females seem to perceive a personality and gender associated with their IT device. These differences between males and females may be the driving force behind their use of technology.

 ISBN: 978-1-61208-369-8

B. *Video Analysis Results*

We used the video annotation to analyse the video records of the experiments. We used seconds as the measuring unit for time. In total, we collected 8 males and 10 females' gestures, but only the ones with better expression and comprehension of the task were chosen for analysis. Therefore, the final selection was 5 for each gender group. There are a total of 157 gestures.

In 5 male participants, the average duration of video is 1min 28 sec and the longest video footage is 1:50 minutes. The total number of gestures in the video records is 72. Male participants used only 4 gesture types in the description of the chair in our experiment. According to the Figure 3, the use of iconic gesture type is 50%, then followed by deictic, junk and beat gesture types. We found higher number of deictic and junk gestures 17% each in males video protocols. We also found male participants did not use metaphoric gestures during the description, and only 3 males performed a metaphoric gesture.

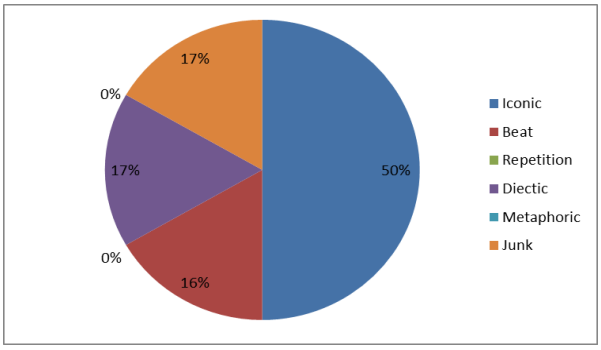

Figure 3: Gesture types used by males

In 5 female participants, the average duration of video is 1 min 48 sec and the longest video is 2:10 minutes. The total number of gestures in the video is 84. Female participants used all 7 types of gestures in the description of the chair in our experiment. According to the Figure 4, the iconic gestures were more than 50% in the all video records, followed by deictic, junk metaphoric, repetition and junk gestures. The beat gestures are used the least by females. Both males and females use plenty of junk gestures but the portion of junk gestures is smaller in females (11% vs 17%) .

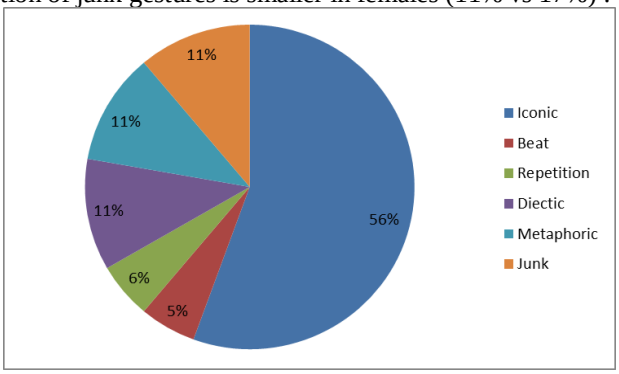

Figure 4: Gesture types used by females

Comparing Figure 3 and Figure 4, we found male participants only use 4 types' gestures out of 7. However, females make use of all 7 types. Some female participants would even use metaphoric gestures. We found that females are more diversified compared to males in their gesture types.

Analysing the results in Table 8, we found that females use more gestures in a longer period (84 vs 72 gestures and 1:48 vs 1:28 seconds on average). We found that frequency of gestures is higher in females (2.39 vs 1.78). On the other hand, males perform less number of gestures in a shorter time frame (25.6 sec vs 40.2sec).

TABLE VIII: COMPARATIVE ANALYSIS

	Total video duration	Avg video duration	Total num.of gestures	Avg gestures per participant	SD	Total gesture time	Ave gesture time	Frequency
Male	384 sec	76.80 sec	72	14.4	8.24	128 sec	25.6 sec	1.78
Female	444 sec	88.75 sec	84	16.8	9.12	201 sec	40.2 sec	2.39

The total duration of video is larger in female participants. The video records comprise both gestures and speech. Females' descriptions are longer. The total gesture time is nearly as twice as male participants in females.

The most significant finding in both genders for a gesture based interface design is the ratio of iconic gestures as these are the most frequent gesture types in both protocols (50% for males and 56% for females).

Detailed description of the abbreviations defined in Table 6 can be listed as follows as in Nasser and Kavakli [4]:

Total video duration: The total video duration is measured as the sum of total duration of each participant.

Average video duration: The average video duration is measured as the number of total video duration divided by the number of the participants.

Total number of gestures: The total number of gestures is measured as the sum of the total gestures of each participant used in the video.

Average gestures per participant: The average gesture per participants is measured as the number of total gestures performed by the participants divided by the number of the participants. This way we get the average gestures performance for each gender.

Total gesture time: The total gesture time in the video records.

Average gesture time: The average gesture time is measured as the number of total gesture time divided by the number of the participants.

Frequency: The frequency is measured as the number of gestures performed by a participant divided by the gesture time period of the same participant. This way we get the gestures per second and it will help assess speed of gesture performance and point out what gestures are most significant for the gesture recognition system

 ISBN: 978-1-61208-369-8

C. *Structural Analysis Results*

To analyse gender differences in the functional description of a chair, we divided the sample chair into different parts (Figure 5): seat, back, bars and legs. Each part is connected to another part. In Figure 6, we found gender differences in the functional description of a chair . Females tend to describe the chair following a part based description. For example, first they tend to describe the leg followed by the other legs, then they start pointing out the rungs. Then follow by the seat and back of the chair. Females' seem to refer to a structural description in their description. However, males description of these functional parts is random.

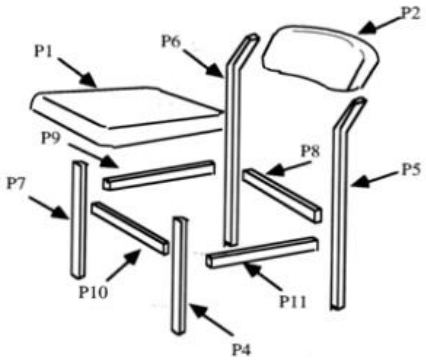

Figure 5: Parts of a chair [24]

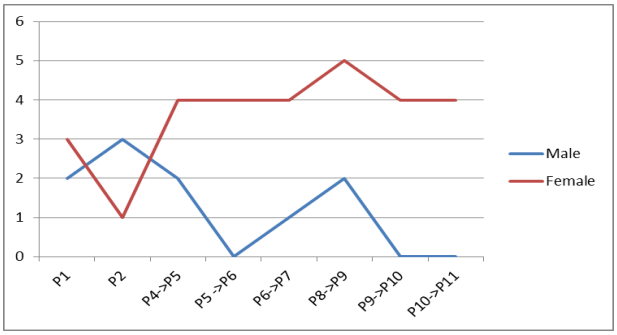

Figure 6: Number of participants and functional parts of a chair

VI. CONCLUSION AND FUTURE WORK

Our motivation to examine gender differences originates from ubiquitous system development for gesture recognition [25] suggesting to use multimodal input for adaptive system design [26]. Gender differences found in psychology, computer science, marketing, neuroscience, education, and economics that strongly suggest that males and females solve problems, communicate, and process information differently.

We defined two hypotheses to test: (1) The experience of using a computer as well as the gender of the user has a significant effect on the perception of the gender of the technology. The objective of the survey in this study is to investigate this research question. (2) Gender differences in gestures have a significant influence on human performance.

Regarding Hypothesis 1, there are gender differences in the perception of the gender of technology. While desktop computers seem to be perceived as a more masculine technology (43.3%), mobile phones are perceived more feminine (50%). Laptops have no gender (68%), neither does the Internet (73%). When comparisons are drawn between males and females, all male participants consider the Internet with no gender at all. Majority of males think that their IT device has no gender. Still, if there is a gender associated with it, desktop is masculine (40%), mobile phone (20%) and laptop are feminine technologies (14.2%). More than 86.6% of females think that their desktop has a gender. Their perception of mobile technology is primarily feminine (80%) but their laptop (36.3%) and internet (33.3%) are partially feminine, while majority of them think that their laptop and internet has no gender. These findings imply that while males show a tendency to objectify the technology, they do not seem to see the personality or gender behind their IT device, whereas a large proportion of females seem to perceive a personality and gender associated with their IT device. These differences between males and females may be the driving force behind their willingness of the use of IT. We also found that 53.3% of males spend more than 6 hours on a computer each day, however only 33.3% of females spend 4- 6 hours on a computer each day. Perhaps, as a result of this, most females consider themselves as beginners in computer use (92%), however most males (92%) consider themselves as intermediate or professional users of computer.

Regarding Hypothesis 2, there are gender differences in the use of gestures. We found male participants only use 4 types' gestures out of 7. However females make use of all 7 types. Females seem to be more diversified compared to males in their gesture types. We found higher number of deictic and junk gestures 17% each in males' video protocols, as well as no use of metaphoric gestures. Iconic gestures are the most frequently used gestures in both protocols (50% for males and 56% for females). The beat gestures are used the least by females. Both males and females use plenty of junk gestures but the portion of junk gestures is smaller in females (11% vs 17%). Females use more gestures in a longer period (84 vs 72 gestures and 1:48 vs 1:28 seconds on average). Frequency of gestures is higher in females (2.39 vs 1.78). We also found gender differences in the functional description of a chair. This implies that males and females may employ different cognitive processing methods. Females tend to describe the chair following a part based description and referring to a structural description. However, males' description of these functional parts seem to be random.

It is important to state that these are only some pilot studies. Future studies require a larger sample size and must focus on the consistency of the annotations using independent coders. It would be useful to collect some psycho-physiological feedback to verify these results. Further, research may also investigate the combined effects of gender and culture on gesture performance.

 ISBN: 978-1-61208-369-8

ACKNOWLEDGMENT

This research is supported by the Australian Research Council Discovery grant titled "Gesture Recognition in Virtual Reality". Also, the experiment on which this project was inspired by Jing Liu's PhD topic and her previous work titled "Temporal Relation between speech and co-verbal iconic gestures in multimodal interface design".

REFERENCES

[1] M. Gullberg, 'Methodological reflections on gesture analysis in second language acquisition and bilingualism research'. Second Language Research 26,1; 2010, pp. 75–102.

[2] M. W. Kruger, 'Environmental technology: Making the real world virtual', Commun.ACM 36, 7 (July), 1993, pp. 36 –37.

[3] J. Brewer, A. Bassoli, 'Reflections of gender, reflections on gender: Designing ubiquitous computing technologies'. In Gender & Interaction: Real and Virtual Women in a Male World, Workshop at AVI, 2006, pp .9–12.

[4] K. Nasser, M. Kavakli, 'Influence of Culture in Multimodal Interfaces: Differences in Gesture behavior between Anglo-Celtic and Latin Americans', *the International Journal On Advances in Life Sciences*, v 4 n 3&4, 2012, pp. 1-10.

[5] A. Herlitz, L.G. Nilsson, and L. Backman, 'Gender differences in episodic memory'. Memory & cognition 25(6), 1997, pp. 801.

[6] D. C. Geary, S. J. Saults, F. Liu, and M. K. Hoard, 'Sex differences in spatial cognition, computational fluency, and arithmetical reasoning'. Journal of Experimental Child Psychology 77(4), 2000, pp. 337.

[7] J. S. Hyde, E. Fennema, and S .J. Lamon, 'Gender differences in mathematics performance: a meta-analysis'. Psychological bulletin 107(2), 1990, pp. 139.

[8] C. Kramer, 'Perceptions of female and male speech'. Language and Speech 20 (2), 1977, pp. 151.

[9] N. Briton and J. Hall, 'Beliefs about female and male nonverbal communication'. Sex Roles 32(1), 1995, pp. 79.

[10] E. V. College, 'Gender difference in nonverbal communication', 2014, http://evc-cit.info/psych018/observation_samples/observation9028.pdf [Online; accessed August 2014].

[11] J. Freeman. 'Women: A feminist perspective', (4th ed) Mountain View, CA: Mayfield Publishing Company, 1992, pp. 329–46.

[12] D. M. Saucier and L. J. Elias. 'Lateral and sex differences in manual gesture during conversation'. Laterality: Asymmetries of Body, Brain and Cognition 6 (3), 2001, pp. 239.

[13] H. Cochet and J. Vauclair. 'Hand preferences in human adults: Non-communicative actions versus communicative gestures'. Cortex 48(8), 2012, pp. 1017.

[14] D. Gefen, and D. Straub, 'Gender Differences in the Perception and Use of E-mail: An Extension to the Technology Acceptance Model'. *MIS Quarterly*, 1997 pp. 389-400.

[15] M. Volman, E. Eck, I. Heemskerk, E. Kuiper, 'New technologies, new differences'. Gender and ethnic differences in pupils' use of ICT in primary and secondary education. DOI: 10.1016/j.compedu.2004.03.001, 2004.

[16] S.G. Mazman & Y. Usluel, 'Gender differences in using social networks'. The Turkish Online Journal of Educational Technology, April 2011, Vol.10 Issue 2, (2011).

[17] H. Ono, M. Zavodny, 'Gender differences in information technology usage: A U.S – Japan comparison'. *Sociological Perspectives, Vol.48 Issue 1*, 2005.

[18] D.McNeill. Hand and Mind: what Gestures Reveal about Thought, University of Chicago Press, 1992.

[19] W. Fikkert, P. Van der Vet, G. Van der Ver, A. Nijholt, 'Gestures for large display control . Computer Interaction': 8th International Gesture Workshop, Revised Selected Papers. Germany: Springer, 2009, pp. 245-256.

[20] H. Li, M. Greenspan, 'Model-based segmentation and recognition of dynamic gestures in continuous video streams'. Pattern Recognition, 44, 2011, pp. 1614-1628 Retrieved from ScienceDirect Database.

[21] H. Kang, C. Lee, & K. Jung, 'Recognition-based gesture spotting in video games'. Pattern Recognition Letters 25, 15, pp. 1701-1714. DOI:10.1016/j.patrec.2004.06.016, 2004.

[22] Hofstede G. H., Hofstede G. J., Minkov Michael () *Cultures and organizations: software of the mind : intercultural cooperation and its importance for survival*. (3rd ed) McGraw-Hill Professional ISBN 0071664181, 9780071664189, 2010.

[23] Anvil, http://www.anvil-software.org/, 2014 [Online;accessedAugust-2014].

[24] M. Kavakli, S.A.R. Scrivener, L.J. Ball, 'Structure in idea sketching behaviour', *Design Studies:* The International Journal for Design Research in Engineering, Architecture, Products and Systems, ELSEVIER, 19(4), 1998, 485-517.

[25] M. Kavakli, 'Gesture Recognition in Virtual Reality', *Special Issue on: "Immersive Virtual, Mixed, or Augmented Reality Art" of The International Journal of Arts and Technology* (IJART), Vol 1, No 2, 2008, pp. 215-229.

[26] J. Liu, , M. Kavakli, Towards Accommodating Gender Differences in Speech-Gesture Based Multimodal Interfaces Design, ICITA 2013, 8th International Conference on Information Technology and Applications, Sydney, Australia, 1 - 4 July, pp.1-6, 2013.

 ISBN: 978-1-61208-369-8