Gender Differences in IT Adoption & Gestural Communication

Science Behind Stereotypes & Implications on Human Computer Interaction

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***Abstract*— This paper reviews gender differences in gestural communication and perception of Information Technology (IT) and investigates gender differences in basic hand gestures for the design of user-centric and gender-adaptive systems. If males and females associate themselves differently with technology, being masculine and feminine, then this would have a strong impact on their adoption of IT and would require the development of gender-adaptive gesture-recognition systems, devices and applications. In this paper, we present empirical studies to demonstrate gender differences in the perception of technology as well as gestural communication. We have conducted a survey with 20 male and 20 female participants and found differences in the perception of the gender of technology. Our association with IT may be driven by the way we identify ourselves with the gender of technology. If there are differences in the way we process information and males and females use different system architectures, then the development of gender-adaptive systems would increase the acceptance of technology. We have also analysed natural hand gestures to identify what type of gestures are used in gestural communication, using video analysis and annotation. We have conducted an experiment involving 10 male and 10 female Australian adults. We have asked the participants to describe an object using hand gestures and speech. We have found gender differences in the perception of IT, as well as types, frequency and occurrences of hand gestures. Drawing conclusions from these comparisons, we discuss the potential effects of gender differences in the design of multimodal interfaces as well as the necessity of developing gender-adaptive systems in Human Computer Interaction (HCI).**

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

I. Introduction

Gender differences have long been debated in a number of disciplines such as education, sociology, psychology, neuroscience, and medicine. In this article, we provide a debate on this controversial issue and the science behind stereotypes. Our goal is to draw parallels between the perception of the gender of Information Technology (IT) and gender differences in our interest in so-called masculine and feminine technologies, as we believe to motivate females' interest in IT, we must start developing feminine technologies that females feel more associated with.

Gender differences in gestural communication [1] have been studied by many researchers, leaving much unclear regarding the implications on Human Computer Interaction (HCI). As shown by Nasser and Kavakli [2], culture has an impact on gestures, but these stereotypes may be incorrect. Nasser and Kavakli [2] have shown that Anglo-Saxons uses gestures more than Latin-Americans but since the frequency of gestures is higher in Latin-Americans, this gives an impression as if they use more gestures. In fact, Latin-Americans use faster but less gestures.

Our aim in this paper is to look into another stereotype and investigate gender differences in gestural communication between males and females in order to develop personalized interfaces. To identify gender differences in the perception of IT as well as gestural communication, we defined two hypotheses to test:

(1) Users' gender and their computer experience have a significant effect on the perception of the gender of IT.

(2) Gender differences in gestural communication have a significant influence on user association and the perceived gender of technology and in return these may affect the acceptance of technology.

Our association with IT may be driven by the way we identify ourselves with the gender of technology. There may be gender differences in the way we process information, as well as our perception regarding the masculinity and femininity of the technology. If males and females use different system architectures to process information, the development of gender-adaptive systems would increase the acceptance of technology.

The paper is structured as follows: Section I presents a debate on the influence of gender on technology adoption and gestural communication in HCI. Section II reviews summary of related works regarding gestures and gender differences in gestural communication. Section III describes the methodologies used. Section IV addresses the survey on the perception of IT and the experiments on the use of hand gestures. Section V goes into finer details with respect to the analysis of the data collected. Section VI presents the findings. The conclusions close the article.

II. GENDER DIFFERENCES IN TECHNOLOGY ADOPTION & GESTURAL COMMUNICATION

In this section, we will look into gender differences specifically in IT adoption and gestural communication.

A. *The Influence of Gender on IT Adoption*

The influence of gender on IT adoption has received a significant amount of attention. In USA, Internet use at various locations increased over time among females relative to males. In 1997 and 1998, females were less likely to use the Internet anywhere or at home than males, but they were more likely to do so by 2001 [3]. Among those who work, females remained less likely than males 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 females the least likely to use the Internet. What drives the change in the statistics? Is it the development of feminine technologies?

As stated in previous studies, the uptake of technology and acceptance of IT has been relatively slow by female users until the introduction of more feminine and gesture-based technologies such as smart-phones and tablets. Two-thirds of U.S. consumers own smartphones today [4], with slightly more women owning one than men [5]. Does association with the gender of technology have anything to do with the adoption of technology? This is still an open research question.

Recent statistics show that females use technology differently than males [6]. Females not only use social media more often than males, but they use it in different ways and to access different kinds of information and entertainment. For example, females use social media for staying in touch, blogging and sharing and researching how-to information, while males use social media for business and dating more than females do. LinkedIn is the only social platform that males use more than females.

Regarding the differences between males and females on the usage of social networks, Tüfekçi [7] similarly found 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 [8]. However, males tend to make new relationships in social networks more than females do. Tüfekçi [7] suggested that females are more social than males and they demonstrate differences in communication styles. Females 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.

The gender gap is lessening as more people are exposed to using technology, but most researchers support the idea that social influences play a much stronger role in technology adoption for females than males [9]. Males appear to be more strongly influenced by their own attitudes toward using new technology, while female's decisions tend to be driven by their perception of others' beliefs that they should or should not adopt the technology [10]. These findings are consistent across income, education, and computer self-efficacy levels. Similarly, Mazman et al. [29] found in 300 prospective teachers (including 234 females and 66 males) that the social influence on females were significantly higher than males in the use of a technological innovation.

On the other hand, the technology adoption is potentially influenced by the tendency of females to assess their technical skills lower than males [11]. Regarding the adoption of technology, ECAR [9] conducted a survey to identify early and later adopters. Mainstream adopters refer to the people stating that they usually use new technologies when most people they know do. Figure 1 shows that about half (49.3%) of the respondents in [9] identify themselves as mainstream adopters, while the percentages drop off for earlier and later adoption categories. The figure demonstrates that 57% of mainstream adopters are females. 33% of the male respondents see themselves as early adopters and 18.7% as innovators (52.0% in total), while just a quarter of females (25.6%) choose these categories.

Which best describes you?	ECAR Descriptor
I am skeptical of new technologies and use them only when I have to.	Laggard
I am usually one of the last people I know to use new technologies.	Late adopter
I usually use new technologies when most people I know do.	Mainstream adopter
I like new technologies and use them before most people I know.	Early adopter
I love new technologies and am among the first to experiment with and use them.	Innovator

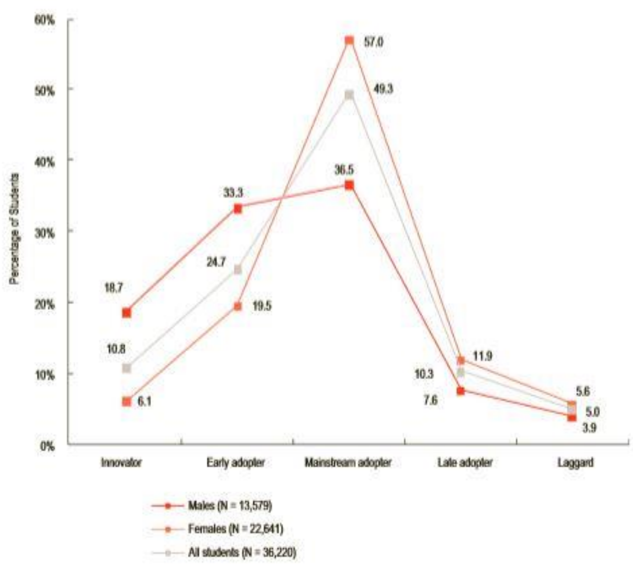

Figure 1. Technology adoption by gender [9]

The adoption of new technologies does not only depend on the gender, but also other social and cultural characteristics. There may be other unobserved non-gender differences that may impact adoption such as access and quality of resources for females. For example, regarding peanut production in Eastern Uganda, Tanellari et al. [12] found that female farmers are less likely to adopt technology than male farmers. Furthermore, they found that females living in female-headed households are less likely to adopt new varieties than females or males living in male-headed households. Their analysis reveals that there are different dynamics between female and male-headed households when it comes to decision making with regard to peanut production.

Studies on the perception of IT show that although males and females in the United States have similar experiences with computers, females have an advantage in typing [13]. 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, there seems to be no perceived difference in the use of computers between nonworking and working men.

B. Gestural Communication

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 the information acquired about them, the context of use and the environment. Therefore, personalization of devices and applications requires a careful analysis of gender differences to be widely accepted by anyone in the community.

HCI systems have evolved significantly starting from the use of mouse input [14] to multimodal systems integrating speech recognition, head and eye-tracking technologies, and static and dynamic hand gestures. Humans have an inherent need to use gestures, as they complement our ideas. To such an extent that humans are known to gesture even when talking on the phone. Gestures are considered as sign languages to externalize human thoughts.

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 for technology has increased 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 of communication conveyed by gestures as the new media of interaction. As a result, computer vision algorithms have improved, since the first VideoDesk [15], which was only detecting the user’s fingers and thumb. Today, it is possible to recognize and respond to the whole body posture [16]. Hand posture detection has been used to give commands to the computer and robotics systems [17, 18] to give mobility to the people in wheelchairs. Hand rotation and movement indicate the parameters to give commands to these systems.

Regarding the individual differences in cognitive processing, controversial views exist. Herlitz et al. [19] state that there are gender differences in verbal, quantitative and visuospatial ability in human cognition. A general view is that males outperform females on visuospatial tasks and females outperform males on verbal fluency. Males show significantly higher mean scores on the arithmetical computations, arithmetical reasoning, and spatial cognition [20]. However, some researchers believe that although there are gender differences in our cognitive abilities (verbal, quantitative, visuospatial) these are quite small, and therefore, insignificant [21]. How small the gender differences in gestural communication and what their effects are on multimodal system design remain to be answered.

It was suggested by Kramer [22] that females more often use facial expression and hand gestures to express their thoughts than males. Regarding nonverbal communication, there are differences between females and males. Females use more expressions and nonverbal behaviors than males. Females are more skilled at sending and receiving nonverbal messages [23]. Males are louder and more interruptive and display more nervous, defluent behaviors. The differences in the mean use of hand gestures are also statistically significant in a social bar setting [24]. Males are likely to use their hands to express themselves and they rely on more obvious gestures. Females, on the other hand, present more subtle gestures and they restrain and exhibit deferential gestures [25].

Regarding hand preferences, Saucier and Elias [26] reveal that the number of gestures made with the right hand during speech is significantly higher for males, however, during listening, the number of gestures made with left hand is significantly higher. This may imply separate parts of brain being employed for processing information for different tasks. There is no evidence regarding the females left or right handed gestures which are associated with right and left sides of brain respectively. However, some other studies state there are no significant differences in the degree of hand preference between pointing gestures produced along with speech and gestures produced on their own [27]. This implies that different parts of brain are used in information processing for performing different tasks.

Cocher and Vauclair investigated the processes underlying gestural communication in children [27] and adults [28] by examining hand shapes and hand preference patterns associated with different types of gestures. They presented several communicative situations eliciting pointing gestures and symbolic gestures to 81 participants in an experiment in [27]. They found some differences in hand shapes depending on the function of pointing: contrary to results reported in children, the proportion of index-finger gestures was higher in imperative situations than in declarative situations. The distance between the gesturer and the referent was also found to influence hand shapes, proximal pointing being more frequently associated with index-finger gestures than distal pointing. The comparison of hand preferences revealed a greater right-sided asymmetry for declarative pointing than for non-communicative activities, whereas there was no difference between imperative pointing and non-communicative activities, or between symbolic gestures and non-communicative activities.

Investigation of tangible HCI technologies suggests that it is important to be cognisant of gender with respect to the interactions they facilitate [30]. However, no specific studies address whether any gender differences are present in the use of gestures or hand preferences, while people communicate with computer systems.

III. GESTURE CLASSIFICATION

The most recognized classification for hand gestures is the one established by McNeill in [31]. McNeill classifies gestures as seen in Table I. 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 [31] identified the gestures types as summarized in Table I.

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

Iconic. Iconic gestures are identified as actual picturing, as if drawing. Therefore, if a participant mentions the word “square” and draw a square, it is considered an iconic gesture.

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

Repetition. Repetition gestures are part of beat gestures, but are counted separately.

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

Metaphoric. Metaphoric gestures represent conceptual subjects. They may represent an abstract concept such as “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 are identified as gestures without a particular meaning. This could be a gesture that the user takes back (a “mistake”) or some transition movements.

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 [32] (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 [33]. 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 severe curvature [34]. Li and Greenspan [33] focus on how the endpoints are located asking participants to 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 must be repeated at a single moderate speed. Gesture model does not have to be perfect.

IV. METHODOLOGY

This section covers the explanations of the methodologies we used in the project. The methodology used for counting gesture frequency, types and occurrence is the same as the methodology used in [2] for addressing cultural stereotypes in gestural communication. Nasser and Kavakli [2] stated that the culture has an impact on the frequency, types and occurrences of certain gestures and this could be explained by Hofstede’s cultural dimensions [35]. This methodology was also used by Kavakli and Chen [1] and Liu and Kavakli [36] for addressing gender differences in information and cognitive processing respectively.

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 on the perception of IT. The age range of participants was 25-30 years old. They came from Asian and Australian backgrounds. They were 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 [37] for video analysis. ANVIL offers multi-layered annotation based on a user-defined coding scheme (Figure 2). 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. 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.

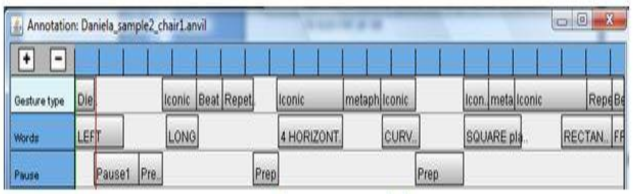

Figure 2. ANVIL annotation track

In video analysis, we used the gesture classification defined by McNeill [31] as used in [1] and Table I. All participants used words to accompany their gestures, even if they were not instructed to do so.

C. Experiments

18 participants including 8 males and 10 females joined the 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 from Australian or Asian backgrounds. The participants were either employed or unemployed. We have chosen a group of males and females with English as their native language. We explained the task to the participants. They were asked to describe a particular object (Figure 3).

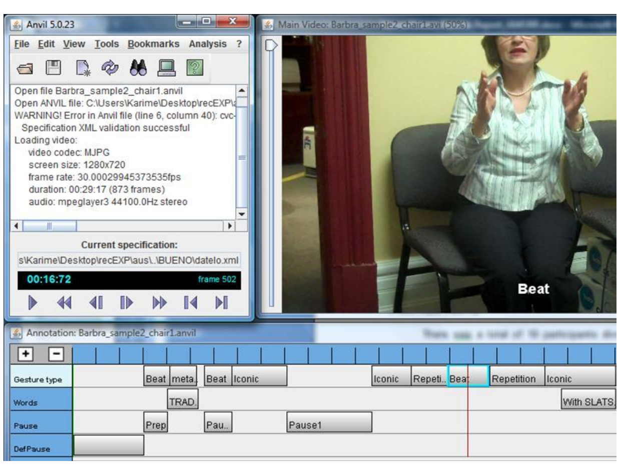

Figure 3. A snapshot from the experiments

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 it as if they were in a videoconferencing session. They were encouraged to use both hands and as many gestures as possible.

V. RESULTS

This section covers the results of survey and experiments.

A. Survey Results and Demographics

Analysing the survey, we found that all male participants perceive themselves as having more experience with computers than female participants. According to Table II, 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 II, either males 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 III, 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.

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TABLE III. PERCEIVED COMPUTER SKILLS

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

According to Table IV, 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. COMPUTER TIME

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 V 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

	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 VI and Table VII, we found that there are gender differences in the perception of the gender of IT. 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, their desktop is masculine (40%), but mobile phones (20%) and laptops are feminine technologies (14.2%) for males.

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 males show a tendency to objectify the technology and 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.

B. *Video Analysis Results*

We used ANVIL video annotation tool 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 this experiment.

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 Figure 4, 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 that male participants did not use metaphoric gestures during the description, and only 3 males performed a metaphoric gesture.

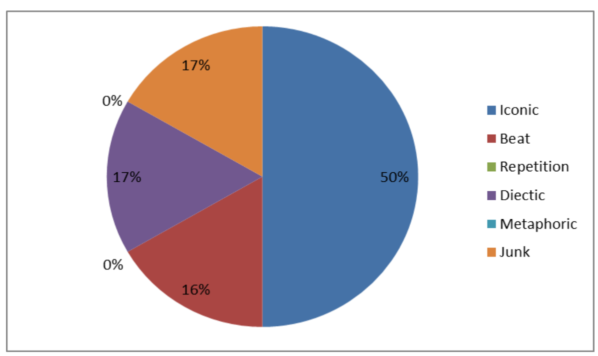

Figure 4. Gesture types used by males

In 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 Figure 5, the iconic gestures were more than 56% in the females' video records, followed by deictic, junk metaphoric, repetition and junk gestures. The beat gestures are used the least by females.

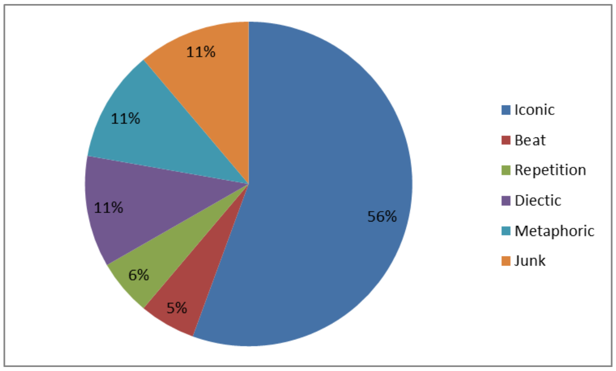

Figure 5. Gesture types used by females

C. *Comparative Analysis*

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). Both males and females use junk gestures but the portion of junk gestures is smaller in females (11% vs 17%). Comparing Figure 4 and Figure 5, we found that 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. Table VIII presents comparative analysis results.

TABLE VIII. COMPARISONS

	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

Analysing the results in Table VIII, we found that females use more gestures in a longer period (84 vs 72 gestures and 1:48 vs 1:28 seconds on average). The 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). 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.

Detailed description of the abbreviations defined in Table VI can be listed as follows as in Nasser and Kavakli [2]:

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.

D. *Structural Analysis Results*

To analyse gender differences in the functional description of a chair, we divided the sample chair into different parts (Figure 6): seat, back, bars and legs. Each part is connected to another part. In Figure 6, we found gender differences in the descriptions of the functional parts of a chair. Functional parts of a chair were described before in [38]. In [38], Kavakli et al. found that chairs are externalized and drawn by fine arts students using a functional description as a mental image.

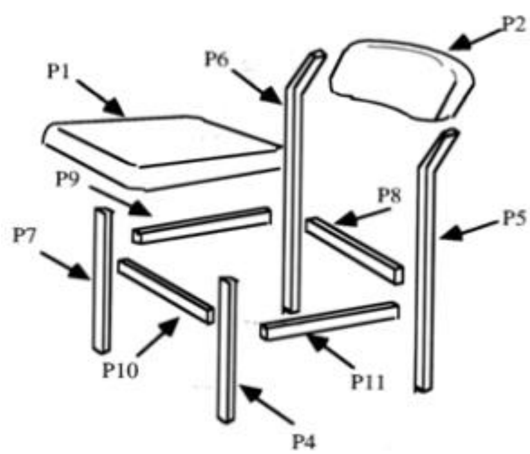

Figure 6. Parts of a chair as used in [38]

The number of males and females describing the specific parts of the chair is demonstrated in Figure 7 following a part based description. Overall, 2 males vs 3 females describe Part1, 3 males vs 1 female Part2, 2 males vs 4 females Part4 and 5, 0 males vs 4 females Part5 and 6, 1 male vs 4 females Part6 and 7, 2 males vs 5 females Part8 and 9, 0 males vs 4 females Part9 and 10, and 0 males vs 4 females Part10 and 11. We found referral to 10 parts of the chair in males vs 29 in females.

We also observed that females' seem to more systematically refer to a structural description in their description. For example, first they tend to describe the leg followed by the other legs, then they start pointing out the rungs, the seat and back of the chair. However, males' description of these functional parts is random.

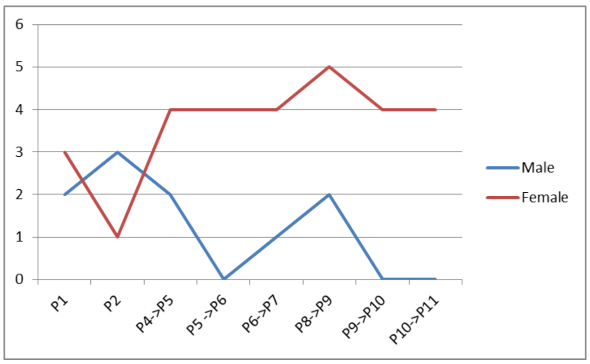

Figure 7. Number of participants describing functional parts of a chair

VI. CONCLUSION AND FUTURE WORK

Our motivation to examine gender differences originates from ubiquitous system development for gesture recognition [16] suggesting the use of gender-adaptive systems in HCI [36]. 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. In this study, we defined two hypotheses to test:

(1) Users' gender and their computer experience have a significant effect on the perception of the gender of IT.

(2) Gender differences in gestural communication have a significant influence on user association and the perceived gender of technology and in return these may affect the acceptance of technology.

Regarding Hypothesis 1, there are gender differences in the perception of the gender of IT. 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%). On the contrary, 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, and do not seem to expect to find a personality or gender behind their IT device, 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 adoption 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, referring to differences in mental imagery. Females refer to functional parts 3 times as much as males. This implies that males and females may employ different cognitive processing methods. Females tend to describe the chairs following a part based description and referring to a structural description. However, males' description of these functional parts seems to be random.

User association with IT may be driven by the way humans process information. If there are gender differences in the way we process information and males and females use different system architectures, then the development of gender-adaptive systems would increase the acceptance of technology.

There is also supporting evidence in behavioral research that there are gender differences in cognitive spatial abilities [39-41]. These may directly impact the ability to perceive, interpret, and cognitively process spatial properties and spatial relationships of visual objects [42]. Males have less computer anxiety [43]. Future research studies should investigate not only psychological but also physiological aspects of gender differences in information processing. In this article, we have presented that these differences may be the reason for females being not so interested in a masculine technology. To motivate females' interest in IT, we must start developing feminine technologies that females feel more associated with as demonstrated in this article.

It is important to state that these are only 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 psycho-physiological feedback to verify these results, such as EEG data sets. Further, research may also investigate the combined effects of gender and culture on gesture performance.

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