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Running head: UAS PRIVACY

Public Perception of UAS Privacy Concerns: A Gender Comparison

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Abstract

Background. While much research has examined engineering and practical uses of UASs, there have been very few studies that have examined privacy concerns that the public may have towards UASs. Even less research has been conducted on how gender and type of UAS mission might affect privacy concerns. **Purpose.** This paper examines gender differences in privacy concerns across a wide array of UAS mission types. We also examine potential mediators that explain why females and males differ in their privacy concerns. **Methods.** A total of 1067 participants were presented with various hypothetical UAS missions across four studies. They were asked to provide privacy concerns scores and related information. **Results.** The results of all four studies conclude that there are distinct gender differences in UAS privacy concerns. These differences are mediated by various factors. **Conclusions.** The researchers conclude that future UAS operation should take into consideration the public's privacy concerns and that these concerns are different for females and males.

Keywords: unmanned aerial system, privacy, public perceptions, type of operator, gender

Introduction

Problem Statement

“Unmanned aerial systems (UAS) can generally be defined as a device used or intended to be used for flight in the air that has no on-board pilot” (Finn and Wright 2012). The applicability of UAS has grown steadily in diverse fields such as traffic monitoring, police assistance, wildfire surveillance, search and rescue operations, military operations, package delivery, agricultural missions, and even passenger and cargo transportation in the future. The sizes of UAS vary from small toy-like devices weighing less than a few pounds to large vehicles resembling the size and structure of a large commercial airliner. Although the advantages of UAS are numerous, the technological advancements of UAS have increased peoples’ concern for their privacy.

Previous research has focused on mission-based UAS flights and measuring the public’s perception of their privacy (Winter, Rice, Tamilselvan and Tokarski 2016). In previous studies, participants were less concerned about their privacy when the UAS was only used for a specific mission, rather than if it was operated continuously. Furthermore, affect (emotion) had a significant impact on participants’ responses with disgust and fear emerging as the two main emotions mediating the relationship between the type of UAS mission and concerns over privacy. The current study attempts to further this research by examining the public’s privacy concerns regarding different UAS mission types and if gender plays a significant role in mediating their concerns.

Literature Review

Privacy Concerns

Protection of citizens' privacy has gained widespread attention with the increase in surveillance technologies that UAS are capable of, such as geo-locational tracking and improved navigation and sensor technology (Cavoukian 2013). This improved technology includes sophisticated zoom cameras and live video streams, infrared thermal imagers, radar, location-based tracking tools, communication interception, listening devices, and other surveillance technologies used to record and transmit digital data to ground control systems (Cavoukian 2013). UAS have helped improve the lives of civil servant workers and military personnel by handling jobs considered "dull, dirty, and dangerous" (Blyenburgh 1999). For example, UAS may be used after natural disasters to search for survivors, mapping underground tunnels, searching for pipe leaks, etc. While these capabilities are certainly positive and improve the lives of citizens, the same capabilities could also be used against citizens to violate their privacy.

The FAA already has several regulations in place to help maintain individuals' privacy; however, thanks to a new court ruling (based on the 2012 FAA Modernization and Reform Act), hobbyist drone operators are no longer required to register their drone with the FAA (Ackerman 2017); which means that if a person feels like their privacy is potentially being violated, they may not be able to identify who the owner of the UAS and take legal action. The lack of government oversight/ legal culpability may increase citizens' concern for their privacy and wellbeing. The recent court ruling coupled with UAS capabilities give rise to several questions: who can and should operate these aircraft? How can privacy and constitutional rights be protected while UAS are in operation? There is a widespread concern among regulating agencies about how to govern and successfully implement policies and procedures to accommodate the rapidly increasing technology with UAS (FAA 2015). Furthermore, for most privacy related issues, jurisdiction rests with each individual State.

94 **Privacy Protection**

95 Concerning the protection of a person's privacy, the biggest safeguard is the Fourth
96 Amendment and the precedents the Supreme Court has set in cases involving privacy. Several
97 cases have already addressed issues of using enhanced equipment, such as thermal imaging,
98 night vision, and binocular vision used for purposes such as to gather information inside a
99 person's home and these methods were deemed unconstitutional. However, none of those
100 technologies are considered general public use, which is one of the main reasons they were
101 judged unconstitutional, whereas UAS are becoming more common every day. To date, no
102 Supreme Court case has focused on a UAS, so it remains to be seen how the judges will decide
103 on this privacy issue concerning a fairly new technology. Fortunately, the Fourth Amendment
104 protects citizens' reasonable expectation of privacy, which is defined as "private residences are
105 places in which the individual normally expects privacy free of governmental intrusion not
106 authorized by a warrant, and that expectation is plainly one that society is prepared to recognize
107 as justifiable" (Matiteyahu 2015).

108 **Gender Differences in Technology Perceptions**

109 As automation increases throughout society, it is important to consider the factors
110 influencing a person's willingness to use or accept a particular type of automation, such as UAS.
111 One factor that could affect a person's willingness to use automation such as UAS is an
112 individual's gender. Currently, the majority of gender research has not focused on the difference
113 in males and females regarding their perceptions of new technology on the market; however,
114 gender does significantly impact how positively or negatively an individual may view a potential
115 new product (Henwood, Parkhill and Pidgeon 2008). Social psychologists and researchers have
116 shown that product development and technology tends to be gendered; as a result, peoples'

interactions with technology may be influenced by gendered assumptions of technology in their society (Kelan 2007).

Evolutionary psychology suggests that females tend to be more cautious and less confident when making decisions involving some type of risk probably due them having a primary focus on parental investment/responsibilities; therefore, they may be more sensitive to situations involving risk (Henwood et al. 2008; Powell and Ansic 1997). UAS are still viewed as a relatively new technology; therefore, people may view them as risky because they are not fully aware of all the costs and benefits associated with UAS, particularly regarding maintaining appropriate levels of privacy protection. The current seeks to understand the relationship between gender, UAS mission type, and any privacy concerns that the public may have regarding this fairly new technology.

Gender Differences in Privacy

Research shows that gender does have a significant effect on an individual's decision-making process (Delaney 2014; Henwood, Parkhill and Pidgeon 2008; Scott and Bruce 1995). Typically, females are more risk averse (less willing to take risks) when making decisions, particularly if that decision involves their loved ones (Byrnes, Miller and Schafer 1999). Additionally, men acted intuitively and emotionally, provided a time-sensitive situation, while women acted more methodical and rational (Delaney 2014). Although UAS are becoming more common every day, many people may still feel threatened by them; therefore, it is expected that females may have more privacy concerns regarding UAS.

UAS Applications and Privacy Violations

Privacy advocates maintain the idea that with UAS, the government will be able to engage in widespread, pervasive surveillance because drones are cheaper and easier to operate

than their manned counterparts (i.e. helicopters). To counter this threat of surveillance, privacy advocates have demanded that enforcement or government officials obtain a warrant before using the technology (McNeal 2014). Furthermore, if drones are deployed for surveilling the public (or an individual), there is also the concern that the UAS could be hacked and private information could be leaked or stolen. “Drone hacking refers to the process of remotely intercepting and compromising drone operations” (Cavoukian 2012). In order to minimize the risk of drone hacking becoming an issue, the Washington-based Electronic Privacy Information Center (EPIC) recommends that the FAA should research how to manipulate UAS mainframes and install encryption codes (Cavoukian 2012). Because the average person may not know the detailed risks and benefits associated with drones, their emotions (affect) will probably play a significant role in how they determine their privacy perception.

Affect and the Six Universal Emotions

When people are asked to make a decision, they are typically influenced by affect, or their emotions (Schwarz 2000; Sayegh, Anthony and Perrewe 2004). “Previous research suggests that emotions, which direct attention, memory, and judgment, can influence decisions more than cognitive thought processes” (Winter et al. 2016). When there is a lack of information, an individual may use their emotion as a piece of information to influence their decision (Schwarz and Clore 2003). While people certainly experience a wide range of emotions, research suggests that emotions can be grouped into six major categories that people experience (anger, disgust, fear, happiness, sadness, and surprise) (Ekman and Friesen 1971).

Furthermore, individuals are fairly accurate at identifying these emotions in other people, particularly if they are from the same culture (Ekman and Friesen 1971; Elfenbein and Ambady 2003; Matsumoto 2009). Previous research has used simple pictures to depict these emotions

when having participants report emotion-type and level of affect (*see Figure 1*); which can help explain the public's perception (Babin and Attaway 2000; Baker and Cameron 1996; Rice and Winter 2015). The current research is intended to examine gender differences in privacy concerns across a wide array of UAV mission types. The research will also examine potential mediators that may explain why females and males differ in their privacy concerns.

Current Study

The purpose of the current project was fourfold. In Study 1, we examined gender differences in order to determine if females respond differently to privacy concerns compared to males. In Study 2, we examined if those differences were due to significant mediators (e.g., familiarity, value, fun factor, or emotions). In Study 3, we broadened the scope of the UAS missions to include missions by online sales companies, government, real estate, law enforcement, hobbyists, military, construction, or unmarked/unknown. Finally, in Study 4, we replicated the findings of Study 3 with a much larger sample size and included qualitative findings from the participants.

In Study 1, we presented following hypotheses:

Ha₁: In general, participants will have privacy concerns about UAS missions near their homes.

Ha₂: UAS Privacy concerns would be differentially affected by gender; this was a non-directional hypothesis.

Methods – Study 1

Participants

The data in our study included 295 (142 females) participants from the United States, who were recruited based on convenience sampling strategy through Amazon's © Mechanical

Turk © (MTurk). MTurk is an online method for gathering research participants, who are willing to complete human intelligence tasks for monetary compensation. MTurk has been shown to be as reliable as traditional methods of gathering participants (Germine et al. 2012; Rice, Winter, Doherty and Milner 2017). The mean age of participants in our study was 35.60 ($SD = 10.62$).

Materials and Procedure

Participants were first given a consent form to sign and then provided with instructions. Following this, they were presented with a definition of unmanned aerial vehicle (UAS). They were then presented with the following scenario, “*Imagine that an unmarked UAV is passing by your home at about 300 feet in the air. This UAS appears to have full video capabilities.*” Then they were asked to fill out a UAS Privacy Concerns scale (see Appendix A) that was previously validated by (Mehta, Rice, Winter, Moore and Oyman 2015). Lastly, they filled in basic demographics information. Upon completion, participants were debriefed and paid.

Design

The study used a causal comparative design in order to test gender differences.

Results – Study 1

The data from the Privacy Concern scale was first subjected to Cronbach’s Alpha and Guttman’s Split-Half tests. The results were 0.96 and 0.95, respectively, ensuring that the scale had high internal consistency and reliability. A t-test revealed a statistically significant difference between females ($M = 1.06$; $SD = 0.83$) and males ($M = 0.82$; $SD = 0.87$), $t(293) = 2.44$, $p = .015$, $d = 0.29$, two-tailed.

Discussion – Study 1

The results of Study 1 were straightforward. The data reveal that females have more privacy concerns about UAS missions near their home compared to men. We expand on these findings, and the theoretical reasons behind them, in the general discussion.

Introduction – Study 2

The results from Study 1 indicated that there exist gender differences when asking participants to rate their privacy concerns about a UAS mission near their home. The purpose of Study 2 was to expand on this finding and provide possible mediators that would explain the relationship between Gender and Privacy Concerns. In Study 2, we introduced nine potential mediators. The first three were previously validated scales that measured UAS familiarity, perceived value, and perceived “fun factor” of UASs. The last six potential mediators were the six universal emotions described in the introduction. We hypothesized the following:

Ha₁: In a replication of Study 1, there would be gender differences; that is, females would be more concerned about privacy issues compared to males.

Ha₂: At least one of the potential mediators would explain the relationship between Gender and Privacy Concerns; that is, it would explain why females have more privacy concerns compared to males.

Methods – Study 2

Participants

The data from Study 2 included 291 (121 female) participants from the United States. The mean age of participants in our study was 36.12 (*SD* = 11.20). All participants were recruited via Amazon’s © Mechanical Turk © (MTurk).

Materials and Procedure

Study 2 was identical to Study 1 with the following exceptions. First, we added three previously validated scales measuring familiarity of UASs, the perceived value of UASs, and perceived Fun Factor of UASs. Second, we asked participants to rate how they felt about the hypothetical scenario based on images (see Figure 1) of the six universal emotions (Ekman and Friesen 1971). Participants were shown each image in random order and asked, “*Based on the scenario above, how strongly do you feel like the image shown?*” Participants manipulated a slider with their computer mouse. The slider had scale ends of “I do not feel this way at all” to “I extremely feel this way”. The slider scored the responses on a numerical scale from 0 – 10; however, participants were not aware of this.

Design

The study used a between-participants’ causal-comparative design with Gender as the main independent variable and Privacy Concern Scores as the dependent variable. The study further used a correlational design in order to test a causal mediation model using Hayes’ bootstrapping.

Results – Study 2

Cronbach’s Alpha tests were conducted on the three UAS scales (familiarity, value, and fun factor), as well as the Privacy Concern Scores. The results were 0.85, 0.87, 0.92, and 0.96, respectively. These results indicate high internal consistency in the scales. Guttman Split-Half tests were also conducted on the scales. The results were 0.84, 0.89, 0.89, and 0.95, respectively. These results indicate high reliability in the scales. Thus, the scores in each of the scales were averaged for the following analyses.

A t-test comparing females ($M = 0.87$; $SD = 0.88$) to males ($M = 0.46$; $SD = 0.97$) revealed a significant difference, $t(289) = 3.70$, $p < .001$, $d = 0.43$, in Privacy Concern scores. As found in Study 1, females had more privacy concerns about the UAS mission near their home.

The standardized regression coefficient between gender and privacy concerns was statistically significant. The significance of this indirect effect was tested using bootstrapping procedures (Hayes 2013) with 10,000 bootstrapped samples. For Value, the bootstrapped 95% confidence interval ranged from 0.002 to 0.144. For Anger, the bootstrapped 95% confidence interval ranged from 0.001 to 0.152. Thus, the indirect effect was statistically significant, and there was mediation for Value and Anger. The other variables were not found to be significant mediators.

Discussion – Study 2

The results from Study 2 replicated, and expanded on, the findings in Study 1. First, we replicated the finding that females have more privacy concerns about UAS missions near their home compared to males. Second, the mediation analyses revealed that the reason why females have more privacy concerns is due to less perceived value in UASs, and anger at the possibility of a UAS flying close to their home. We expand on these findings in the general discussion.

Introduction – Study 3

In Studies 1 and 2, the data revealed that females have more privacy concerns about UAS missions near their home compared to males. The data also revealed that the reason for these heightened concerns lies in less perceived value of UASs, and anger about UASs flying close to their home. However, in both studies, we only used one hypothetical scenario; that is, the UAS was unmarked and had no known mission purpose. Clearly, not all UAS missions are identical, and privacy concerns would intuitively differ as a function of UAS mission type. Therefore, in

Study 3, we included the following mission types: online sales, government usage, real estate, law enforcement, hobbyist, military, construction, and unmarked (this last one replicating Studies 1 and 2). The hypotheses in Study 3 were ground in an earlier study conducted by members of the research team (LePore and Winter 2016). We hypothesized the following:

Ha₁: In a replication of Studies 1 and 2, there would be gender differences; that is, females would be more concerned about privacy issues compared to males.

Ha₂: There would be a main effect of UAS mission type; that is, privacy concerns would be differentially affected by the type of UAS mission involved.

Ha₃: There would be a significant interaction between Gender and UAS mission type; that is, the difference in privacy concerns between females and males would differ as a function of UAS mission type.

Methods – Study 3

Participants

The data from Study 3 included 155 (83 female) participants from the United States. The mean age of participants in our study was 35.94 (*SD* = 11.95). All participants were recruited via Amazon’s © Mechanical Turk © (MTurk).

Materials and Procedure

Study 3 was identical to Study 1 with the following exception. Instead of using just one UAS mission type, we included the following mission types: online sales, government usage, real estate, law enforcement, hobbyist, military, construction, and unmarked (this last one replicating Studies 1 and 2).

Design

The study used a two-way mixed factorial design with Gender (between-participants) and Mission Type (within-participants) as the independent variables, and Privacy Concern scores as the dependent variable.

Results – Study 3

A two-way analysis of variance was conducted on the data, revealing a main effect of Mission Type, $F(7, 1064) = 41.57, p < .001, \text{partial-eta-squared} = .22$. However, this main effect was qualified by a significant interaction between Gender and Mission Type, $F(7, 1064) = 2.47, p = .016, \text{partial-eta-squared} = .016$, revealing that gender differences were affected by the type of UAS mission. As can be seen in Figure 2, females did not always have higher privacy concerns compared to males. An analysis of the simple main effects for gender revealed that males and females were only significantly different in their privacy concerns in the unmarked condition, $F(1, 152) = 8.03, p < 0.01, \text{partial eta squared} = 0.05$, where females had more privacy concerns ($M = 3.30; SD = 1.13$) than males ($M = 2.75; SD = 1.30$). An analysis of the simple main effects of Mission Type revealed significant differences in privacy threats for both males, $F(7, 490) = 22.21, p < 0.001, \text{partial eta squared} = .241$, and females, $F(7, 574) = 21.92, p < 0.001, \text{partial eta squared} = .211$.

Discussion – Study 3

The purpose of Study 3 was to determine if gender differences existed across all types of UAS mission, or if they were dependent on the mission type. In both Studies 1 and 2, the mission type was unknown to the participant. In Study 3, we replicated the findings from the unmarked UAS mission type, and revealed that female privacy concern scores were indeed differentially affected by mission type, although this was only significant in the unmarked condition. We discuss the theoretical and practical implications of these data in the general discussion.

Introduction – Study 4

In Study 3, the data revealed that gender differences are affected by the type of UAS mission. The purpose of Study 4 was to replicate this finding with larger sample size and to add in qualitative feedback given by participants as to why they answered the way they did. We hypothesized the following:

- Ha₁: In a replication of Studies 1, 2, and 3, there would be gender differences; that is, females would be more concerned about privacy issues, in general, compared to males.
- Ha₂: There would be a main effect of UAS mission type; that is, privacy concerns would be differentially affected by the type of UAS mission involved.
- Ha₃: There would be a significant interaction between Gender and UAS mission type; that is, the difference in privacy concerns between females and males would differ as a function of UAS mission type.

Methods – Study 4

Participants

The data from Study 4 included 326 (125 females) participants from the United States. The mean age of participants in our study was 33.71 (*SD* = 9.73). All participants were recruited via Amazon’s © Mechanical Turk © (MTurk).

Materials and Procedure

Study 4 was identical to Study 3 with one exception: participants were asked to provide qualitative feedback about their answers. Specifically, they were asked, “*What about the UAV missions made you feel concerned about your privacy?*” and “*What about the UAV missions made you feel NOT concerned about your privacy?*” These questions were open-ended, with no length limits.

Design

The study used a two-way mixed factorial design with Gender (between-participants) and Mission Type (within-participants) as the independent variables, and Privacy Concern scores as the dependent variable. We also added a qualitative portion of the study, whereby participants could give open-ended explanations about their responses.

Results – Study 4

A two-way analysis of variance was conducted on the data, revealing a main effect of Gender, $F(1, 324) = 5.63, p = .018, \text{partial-eta-squared} = .017$, and Mission Type, $F(7, 2268) = 73.33, p < .001, \text{partial-eta-squared} = .19$. However, these main effects were qualified by a significant interaction between Gender and Mission Type, $F(7, 2268) = 2.54, p = .013, \text{partial-eta-squared} = .008$, revealing that gender differences were affected by the type of UAS mission. An analysis of the simple main effect of gender revealed significant differences for online sales, $F(1, 324) = 5.12, p < .05, \text{partial-eta-squared} = .016$, where females ($M = 2.61; SD = 1.33$) had higher privacy concerns than males ($M = 2.27; SD = 1.28$), for real estate, $F(1, 324) = 4.25, p < .05, \text{partial-eta-squared} = .013$, where females ($M = 2.30; SD = 1.12$) had higher privacy concerns than males ($M = 2.01; SD = 1.24$), for construction, $F(1, 324) = 9.60, p < .01, \text{partial-eta-squared} = .029$, where females ($M = 2.17; SD = 1.29$) had higher concerns for privacy than males ($M = 1.73; SD = 1.22$), and for unmarked, $F(1, 324) = 13.90, p < .001, \text{partial-eta-squared} = .041$, where females ($M = 3.52; SD = 0.89$) had higher concerns for privacy than males ($M = 3.11; SD = 1.01$). An analysis of the simple main effects for gender revealed significant differences for both males, $F(7, 1400) = 52.74, p < .001, \text{partial-eta-squared} = .209$, and females, $F(7, 1400) = 28.50, p < .001, \text{partial-eta-squared} = .187$.

Qualitative Findings

Three hundred and twenty (124 female) participants completed the qualitative part of the survey instrument. Quantitative data, as described in the previous section, provides a useful descriptive snapshot, as well as inferential conclusions. However, a secondary goal of the present research was to explore the qualitative responses of participants. Participants were asked why they provided the responses that they did, addressing reasons why they may or may not be concerned about their privacy. To analyze the qualitative results, we employed the use of NVivo, a software program designed to organize, analyze, and code unstructured qualitative data (e.g., interviews or surveys). NVivo allowed for the generation of word clouds, revealing the most common terms and items used by participants to describe their reasons for being concerned (or unconcerned) with their privacy. Figure 4 presents a visualization of the process used to understand the qualitative data collected.

Figure 5 shows the word cloud generated by NVivo. Larger words indicate more frequent use of the terms, while smaller words indicate less frequent usage. Many of the participants were concerned about government intrusion, with some examples below:

“government collecting my personal data”

“Any information collected by government, military could be used against individuals. It's breach of freedom.”

“If the UAV was manned by the military, government, or law enforcement I'd be very concerned because it feels like a new way to collect private information about individuals, which is a big breach of privacy and justice.”

“Any military, law enforcement or government agency gives me some cause for concern.”

Concerns about spying were repeatedly brought up by participants:

387 “i feel like they are spying on me”

388 “They could be photographing me without my consent or knowledge on my private
389 property.”

390 “The fact that they might be filming me or my family”

391 Other participants were also concerned about UAS mission operators gathering information and
392 learning too much about their personal lives.

393 “I don't like that someone can see me in my private home without consent”

394 “My information can be used by anyone in any way they want to shape it and it can end
395 in disastrous consequences.”

396 “The fact that they could be recording/gathering data and that I do not know what this
397 data is being used for.”

398 In response to the second question, a full third of the participants said “nothing”; that is, there
399 was no reason for them to *not* be concerned about their privacy. Most of them indicated that they
400 were indeed concerned, and did not like the idea of UASs passing close to their home:

401 “I would always be concerned unless it's been made public as to why”

402 “i'm completely concerned”

403 “I AM CONCERNED ABOUT ALL UAV AND MY PRIVACY.”

404 “I can't think of anything that DIDN'T make me worried to some extent. If one of those is
405 up there, I feel like I'm being unreasonably monitored.

406 A few participants provided reasons why they might not be concerned about their privacy, and
407 most the answers involved either trusting the agencies, or not having anything to hide:

408 “I don't really do anything that could be used against me.”

409 “If I felt there was a legitimate reason for the UAV to not be concerned with me”

“If they're being conducted by a group that would be concerned with safety, I'm less concerned. Also, if it's something like a real estate company, they may just be trying to get an aerial view of a neighborhood so I'm not the concerned.”

“The military's missions would be less concerning since they are probably just training people to use them for our safety.”

Discussion – Study 4

Study 4 replicated Study 3, while providing more participants and more statistical power. The data revealed differences in gender ratings for online sales, real estate, construction and unmarked. The additional statistical power revealed a difference in real estate not found to be statistically significant in Study 3, although it was in the same direction. We also collected qualitative data and found that participants had concerns about their privacy, being spied on, and the type of agency collecting the potentially invasive data.

General Discussion

Quantitative Findings

The purpose of the current studies was to examine gender differences in relation to privacy concerns about UAS missions. Across four studies, we hypothesized that females would, in general, have more privacy concerns compared to males. In Study 2, we predicted that this would be mediated by either emotions or familiarity, perceived value, or perceived fun factor of UASs. In Studies 3 and 4, we predicted that the gender differences would be differentially affected by the type of UAS mission. And lastly, in Study 4, we provided participants with the opportunity to respond to open-ended questions about their decisions.

The first overall prediction was strongly supported by the data. In all four studies, females, in general, had higher privacy concern scores compared to males. Though not

previously studied in this particular domain, the current results are in line with multiple different veins of research. Conceptually, a UAS flying overhead could be considered a risk. There is a considerable body of literature which notes that females show less risk-taking behavior than males (e.g., Powell and Ansic 1997) which could translate into the higher level of concern seen in the present studies. In addition, females have shown a stronger preference for privacy and higher perceived risk in cyber domains such as social media or online shopping (Sheehan 1999; Garabino and Strahilevitz 2004; Fogel and Nehmad 2008).

The second overall prediction was also strongly supported by the data. Of the nine potential mediators, two turned out to be significant mediators of the relationship between Gender and Privacy Concern scores. Males tended to perceive more value in UASs, while females tended to be more angry about UAS missions over their home. The importance of affect in decision making is well-known (e.g., Lowenstein and Lerner 2003) and is known to influence consumer willingness to fly in an aircraft with an automated cockpit (Rice and Winter 2015). Though not a direct parallel, this comparison does show the tendency of emotion to strongly influence individuals' reactions to new technologies they may not fully understand. Additionally, the finding that value judgments influence privacy concerns makes intuitive sense – if an individual understands the value and benefit of technology (UAS usage, in this case) they will likely be less critical of it.

The third overall prediction was supported by data in Studies 3 and 4. Of the eight possible UAS mission types, females showed higher privacy concerns scores in almost all mission types (e.g., real estate, government, military). The one interesting exception was law enforcement, where females tended to have lower privacy concern scores. However, this was not a statistically significant difference. Again, this is largely consistent with the finding that females

are generally more risk-averse and proactive in terms of privacy. In addition, participants trended to have fewer privacy concerns with certain UAS mission types such as construction, hobbyist, and real estate. The highest privacy concern, as shown in Figures 2 and 3, was in response to unmarked, military, and government UASs. Unmarked UASs are an unknown entity, and may elicit such strong privacy concerns due to the fact that there are too many unknown variables in the equation – the UAS could be operated by the government, military, or potentially an organization with malicious intent. There is currently limited literature on individual trust in the government versus the military and in other private industries. However, it is clear that there are some marked differences in privacy concerns dependent on who is operating the UAS in question.

Qualitative Findings

Participants were quite vocal about their feelings towards UAS missions near their home. The vast majority of participants shared concerns about invasion of privacy, different agencies spying on them for various reasons, and potentially invasive video monitoring of their home and surroundings. Some participants felt it would be ok to have UAS missions near their home as long as they were assured that it was for a good reason. Other participants simply indicated that they had nothing to hide, and were not at all concerned. Males and females did not seem to differ too much in their comments, and an equal number appeared to share concerns about the different issues listed above.

Theoretical Contributions

Findings from the four current studies add to the limited body of research concerning UAS privacy. Prior research on mission-based perceptions of UAS usage and privacy has revealed significant privacy concerns, especially for continuously-operated missions (Winter,

Rice, Tamilselvan and Tokarski 2016). The current research contributes further to the understanding of privacy concerns about UAS usage. Gender comparisons consistently revealed that females are more concerned about their privacy than males when UASs are being used. In addition, feelings of anger and decreased perception of value in UASs were shown to affect females concern about UAS privacy violations. Results also yielded differing levels of privacy concerns for different types of UAS usage. Further, the final study investigated individual reactions in the form of qualitative results, yielding unique insights into different types of privacy concerns. Though qualitative data can be very useful in identifying specific reactions and perceptions, it is not always collected and utilized – the current research is the first to explore qualitative results as they pertain to UAS privacy concerns. These findings highlight specific concerns such as the potential of spying, government intrusion, and a general concern over UASs near residential areas.

In addition, the results contribute to the bodies of literature on gender differences and affect. The findings are in line with the general consensus that females are less willing to take risks, and having a UAS overhead could conceptually be considered a “risk.” In addition, the presence of anger as a mediator contributes to the understanding that emotions play a large role in opinions and decision making across a wide variety of domains.

Practical Applications

As UAS popularity increases in the public and private sectors, public opinion will define not only individual reactions to UASs, but also governmental regulations and corporate decisions. The results of the current research will inform individuals and groups about privacy concerns and the nature of these privacy concerns, in order to better serve and market to the public. The first step to changing public perception is understanding public perception. Knowing

that anger and perceived low value in UASs contributes to privacy concerns can provide useful information for UAS operators where appropriate. For example, more information about UAS capabilities and missions may be able to decrease anger and increase perceived value, thereby mitigating privacy concerns. This would be a useful tactic for any UAS user, as those biased against UASs may take action against any UASs they believe to be malicious or suspicious.

In addition, the inclusion of qualitative data in the current research allows UAS users to target specific complaints about UASs such as concerns about personal data collection and spying. Those who are not worried about UAS privacy have cited reasons such as having nothing to hide. However, there is still a potential connotation here that implies the UAS is collecting data and potentially taking video, whether the participant approves or not. A common portrayal of UASs in entertainment media as well as news media involves spying, taking inappropriate videos, and being methods of destruction. The media portrayal, coupled with a general unfamiliarity with UASs may contribute to the substantial privacy concerns. It is possible that education about UASs may inform individuals not only of UAS capabilities, and specific missions, but also the benefit and value of such missions.

Limitations and Recommendations for Future Research

As with all research, the current study does have limitations, the first being usage of a convenience sample from MTurk. MTurk is an online survey system where respondents complete surveys on their own time, in their own place of choosing. Though MTurk is widely used, it is important to note that generalizing to wider populations must be done cautiously. Future research should replicate the current study with other populations to increase the generalizability of these findings. Another limitation is the opportunity for bias in individual responses. Due to limited knowledge of and interactions with UASs, individuals may not have a

correct understanding of UAS usage and capabilities. In addition, recent positive or negative UAS experiences may bias responses. Additional studies could condition participants based on their UAS experience or compare the public, UAS operators, and pilots. Another limitation of this study is the use of hypothetical situations. Due to the constraints of survey research, we are unable to collect behavioral data, and as such are only measuring perceptions and attitudes. Though the results clearly show concern over privacy, behavioral reactions are difficult to predict. Privacy concerns are certainly important, but individual actions against UASs will have a stronger influence over policy and usage.

Conclusions

The results of this project are fairly straightforward. Across four studies, the data show a general distinction between female and male concerns about privacy during UAS missions near their home. If the UAS is unmarked or involved in online sales, real estate, or construction, females tend to have more privacy concerns. During other types of missions, these gender differences are not statistically significant. A mediation analysis revealed that perceived value in UASs and anger about UASs flying nearby the home largely explained the relationship between Gender and Privacy Concerns.

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Figure Captions

Figure 1. Six Universal emotions (Ekman and Friesen 1971)

Figure 2. Data from Study 3 as a function of gender and UAS mission type. Standard error bars are included.

Figure 3. Data from Study 4 as a function of gender and UAS mission type. Standard error bars are included.

Figure 4. Data visualization for NVivo.

Figure 5. What about the UAS missions made you feel concerned about your privacy?

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Appendix A - UAV Privacy Scale (Mehta et al. 2015).

Please respond how strongly you agree or disagree with the following statements:

1. In this situation, I believe that my privacy could be violated by the presence of this UAV.

Strongly Disagree Disagree Neutral Agree Strongly Agree

2. I believe that the owner/operator of this UAV could have access to too much private information about me in this situation.

Strongly Disagree Disagree Neutral Agree Strongly Agree

3. I believe that my control over my own privacy would be lessened in this situation.

Strongly Disagree Disagree Neutral Agree Strongly Agree

4. I would not be comfortable with how much information this UAV could gather about me in this situation.

Strongly Disagree Disagree Neutral Agree Strongly Agree

5. In this situation, the amount of private information that this UAV could gather about me makes me feel uncomfortable.

Strongly Disagree Disagree Neutral Agree Strongly Agree

6. This situation makes me concerned about how my privacy could be violated by the presence of this UAV.

Strongly Disagree Disagree Neutral Agree Strongly Agree

7. This situation generates privacy concerns with regards to the presence of this UAV.

Strongly Disagree Disagree Neutral Agree Strongly Agree

8. In this situation, I feel my loss of privacy is greater than what can be gained through usage of this UAV.

Strongly Disagree Disagree Neutral Agree Strongly Agree

9. In this situation, the presence of this UAV poses a threat to my privacy.

Strongly Disagree Disagree Neutral Agree Strongly Agree

Figure 1. Six Universal emotions (Ekman and Friesen 1971)

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Figure 2. Data from Study 3 as a function of gender and UAS mission type. Standard error bars are included.

Figure 3. Data from Study 4 as a function of gender and UAS mission type. Standard error bars are included.

NVivo © - Qualitative Data Analysis Software – Data Visualization

Figure 4. Data visualization for NVivo.

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