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Does a SWT Reverse Contagion Effect Exist from Humans to Automation?

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This study examines passengers' level of trust after a failure in a member of the flight crew. This study seeks to establish the possible presence of a reverse contagion effect wherein passenger trust in automated system components is affected by an error in a human system element. Trust was measured in five human entities and five automated aids with participants from both India and the United States. The human entities include the pilot, the co-pilot, the flight attendant, the maintenance manager, and the CEO of the airline. The automated aids were the oxygen masks, the auto-pilot system, the airplane's flaps, the landing gear, and the video screens on the backs of the seats. This study was conducted in three stages, including two three-way ANOVAs to determine to effect, and meditation analyses to determine if affect mediates the effect. Participants were posed with two hypothetical scenarios, a control condition and a failure condition. The participants rated their levels of trust in the five different human entities and the five different automated aids. Trust was measured on a 7-point Likert type scale from –3 to +3. Questions relating to the participants' feelings were also asked to measure affect. The results showed a decrease in trust in the automated aid after the human failure, as well as a country effect, and a mediating effect of affect.

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The prevalence and continued development of automation within the aviation and aerospace industries has warranted significant scholarly investigation into the manner in which human operators both perceive and interact with automated systems. To this end, System Wide Trust (SWT) Theory is a theoretical framework which describes the manner in which perceptions of precision and reliability in an independent system component are affected by inaccuracies in other independent components (Rice & Geels, 2010; Geels-Blair, Rice, & Schwark, 2013; Keller & Rice, 2010). Where previous studies focused primarily on the application of SWT Theory to pilot perceptions of independent automated aids, Mehta and Rice (2016) proposed and demonstrated the probable existence of a contagion effect whereby passenger perceptions of human elements within the system are negatively impacted by the failure of an automated aid. Furthermore, the effect may be asserted to apply to human entities who exercise no practical operational control over the aircraft (Mehta & Rice, 2016).

In an attempt to expand on the research of Mehta and Rice (2016), this study seeks to establish to determine if there is a reverse contagion effect wherein passenger trust in automated system components is affected by an error in a human system element. In order to determine the significance of culture in the application of SWT Theory in a reverse contagion scenario, this study will be inclusive of a cross-cultural analysis with participants from both the United States and India. Finally, the study will include a mediation analysis in order to determine whether the perceptions of passengers are based on affect rather than logic.

Trust and Automation

Anywhere in the world when an aircraft safely lands or takes-off, it is a result of decades of innovations, research, and development in technological aspect of various aircraft systems that have played an important role in shaping the aviation industry that we see today. Over the years, accidents per million take-offs have reached a new low (Chialastri, 2012). But, these innovations did not happen overnight. Time and again, the need for improvement came at a heavy price in the form. These accidents led to the discover of loopholes in the systems, technologies, and regulations, which then led to the development of safer and more reliable systems. These improvements lowered the accident rate and increased the reliability and trustworthiness of the industry.

The term automation can be defined in multiple ways. For the context of this research, automation can be defined as the use of a control system and the available information technologies to reduce the need for human work in the production of goods and services (Chialastri, 2012). Arnott (2007) defines trust as one's ability to rely on a third party especially when personal risk is involved. Trust, in some sense, can also be defined as the level of expectation from a certain entity (Hoffman, Johnson, Bradshaw & Underbrink, 2013). For this paper, that entity would be automation. Whenever any expectation is not met, trust level goes down, and often times cannot be repaired or restored to the initial level (Slovic, 1993).

Hoffman, Johnson, Bradshaw & Underbrink (2013) defines the term interpersonal trust as a trustor's willingness to be vulnerable to a trustee's actions on the basis that the trustee will be able to perform in full expectancy of the trustor. In this study, the trustee would be the human entities and the automated aids. This willingness to depend on either a human or a machine depends on various factors which vary for humans and machines.

Trust in automation is a relatively broad concept and level of trust in any given form of automation greatly depends upon the setting that it is being used. Complex algorithms are being developed to use automation in various fields like aviation, manufacturing, and medicine. The ultimate goals of these complex algorithms are to make automation technology as least complicated as possible and assist the performance of the user which, when done by either human or automation is not possible (Fallon, Murphy, Zimmerman & Mueller, 2010). In order to maximize the human machine relationship, the strengths of the automation must be matched with the human's level of trust in the system.

Parasuraman and Riley (1997) stated that one of the key reason why humans are still not completely removed from the system is that humans are reliable, flexible, adaptable, and more creative than the present automation systems. These attributes allow human to react appropriately for unique situations that arise. Particularly, for aviation, there are far too many variables to consider when developing an automation system that can used onboard aircraft. Therefore, it is a reasonable argument that humans need to be present for a full assessment of the situation.

Cultural Considerations

The global nature of the aviation industry warrants the investigation of consumer perceptions across multiple cultures so as to determine how separate cultural groups of people react to similar scenarios. Hofstede (1984) defines culture as "the collective programming of the mind which distinguishes the members of one group or society from those of another" (p. 82). It stands to reason, therefore, that the evaluation of theoretical psychological constructs across multiple cultures is vital to the generalizability of the construct being investigated. The significance of these cultural differences from a commercial aviation perspective is highlighted in scholarly discussions and investigations of crew resource management (Helmreich & Merritt, 1998). Helmreich and Merritt (1998) emphasize the importance of these cultural considerations as the applications of practices based on investigated psychological constructs in one culture may not prove as successful in a difference cultural context. For the purpose of this study, survey responses from the United States and India will be used to identify how consumers from two distinct cultures experience the proposed reverse contagion effect differently, if at all.

In order to more empirically evaluate the differences between cultures, Hofstede (1984) proposed a series of cultural dimensions which attempt to categorize broad cultural phenomena, and explain such phenomena in a manner which allows for the estimation of behavioral responses from members of a given national culture. These dimensions included Individualism versus Collectivism, Large versus Small Power Distance, Strong versus Weak Uncertainty Avoidance, and Masculinity versus Femininity (Hofstede, 1984). The dimension of *Individualism* vs. *Collectivism* describes the degree to which members of a given culture identify

as an individual or as a part of the wider collective (Hofstede, 1984). It describes the degree to which a member of a given society identifies as "'I' or 'we'," (Hofstede, 1984, p. 83). The dimension of *Power Distance* describes the degree to which individuals accept the existence of an unequal distribution of power within an institution. In *Large Power Distance* societies, persons have a tendency to favor and accept significant hierarchical structure. Conversely, members of *Small Power Distance* societies "strive for power equalization and demand justification for power inequalities," (Hofstede, 1984, p. 83). *Uncertainty Avoidance* refers to the degree to which members of a given society accept or reject "uncertainty and ambiguity," (Hofstede, 1984, p. 83). Finally, the dimension of *Masculinity* versus *Femininity* refers to the degree to which members of a culture value "achievement, heroism, assertiveness, and material success," or "relationships, modesty, caring for the weak, and quality of life" respectively (Hofstede, 1984, p. 84). Additionally, this dimension is used to describe the assignments and prevalence of gender roles (Hofstede, 1984).

The justification for the use of the United States and India in order to demonstrate anticipated differences in survey responses due to cross-cultural considerations comes from an empirical application of Hofstede's dimensions in the form of cultural indexes. Hofstede (1984) establishes that, with an Individualism versus Collectivism Index of 91, the United States significantly outscores India, at 48 (Hofstede, 1984). This suggests that, generally, the national culture of the United States may be purported to be significantly more individualistic than the Indian National Culture. Interestingly, Indians, having a median score of 48, can however sometimes display individualistic tendencies (Rice, et al., 2014). With respect to Power Distance, the national culture of India, with a Power Distance Index of 77, is significantly greater than that of the United States which has a Power Distance Index of 40. The remaining dimensions, namely Uncertainty Avoidance and Masculinity-Femininity, also suggest differences between the two national cultures with India scoring lower in both Uncertainty Avoidance and Masculinity (Hofstede, 1984).

Affect

Doss (2009) discusses affect, or emotion, as a significant element of the human condition. It is further established that, while there exists "the Habermasian vision of a rational public sphere," the significance of affect at both an individual and a societal level is such that modern society may be said to have been molded significantly by the expression of human emotion" (p. 10). It is, therefore, of significant importance to consider the effect of affect when investigating trust and risk perception.

Peters, Västfjäll, Gärling & Slovic (2006) states that affect can act as first-hand information during a decision-making process. During the time that requires a person to make a judgment on the given available choices, they tend to consult their emotions first before arriving at any decision. In a phenomenon termed "the affect heuristic," Slovic, Finucane, Peters and MacGregor (2007) establish that "affective responses occur rapidly and automatically" and suggest that the effect of this heuristic plays a significant role in day to day life (p. 1333).

While this is not inherently negative from a research perspective, there are instances in which the ability to manipulate affect may play some role in the resultant response of an

individual to a given stimulus (Slovic et al., 2007). Consequently, Slovic et al. (2007) report that affect is liable to be manipulated via external influence such as music and emotive language, and via internal individual biases. The case for external manipulation is of significant importance to researchers of SWT theory because it implies that the context of a system component failure or the manner in which it is reported to passengers may manipulate their perception of the failure, as well as their subsequent perception of remaining system elements.

Several consumer research studies have showed that emotions play a key role when a person is put in a situation that involves decision-making, and can be a mediating effect in relation to consumer opinions and trust (Mehta, Rice, & Rao, 2016; Mehta, Rice, Winter, & Buza, 2017; Rice, Winter, Kraemer, Mehta, & Oyman, 2015; Winter, Rice, Friendenreich, Mehta, & Kaiser, 2017; Winter, Rice, & Mehta, 2014). As mentioned in the previous section, emotions can cloud a person's ability to make sensible decisions. Although the decisions that are made under the influence of emotions are not worse than those based on logic, but the output that comes out of them may not be as reliable. Heekeren, Schulreich, Mohr, & Morawetz (2017) states that emotions have long since played a major role in the decision-making process, and theoretic approach suggests that both cognition as well as affect play a key role when a person has to make a decision.

Current Study

Previous work that has been done in the field of SWT has focused on pilots' ability to trust automated aids (Rice & Geels, 2010; Geels-Blair, Rice, & Schwark, 2013; Keller & Rice, 2010). Passengers are an integral part of a flight. Their trust in the aircraft they are flying in, their feelings of safety when flying, or their trust in the pilots and the automation are some of the key factors that help in understanding their perceptions of any onboard failures. This paper focuses on passengers' level of trust during a human failure. A situation is presented to the participants from the United States and India where there is an unintentional mistake (failure) made by the pilot.

The study seeks to measure their changes in trust (if any), in five human entities and five automated aids. The human entities are the pilot, the co-pilot, the flight attendant, the maintenance manager, and the CEO of the airline. The automated aids involved are the oxygen masks, the auto-pilot system, the airplane's flaps, the landing gear, and the video screens on the backs of the seats. Sometimes emotions precede over rational decision making, which influences a person's choices, and therefore, meditation analyses are conducted to determine if affect mediates the effect. The hypotheses for the current study were as follows:

H1: In the failure condition, there will be a decrease in trust in the unrelated automated aids or human entities compared to the control condition.
H2: There will be a difference in trust and affect ratings for the unrelated automated aids or human entities as a function of country of origin.
H3: The relationship between the condition and trust will be mediated by affect.
H4: There will be an interaction between the independent variables.

Methods

This study was conducted in three stages in order to lend strength to the findings of the research. The explanation regarding each stage will be detailed in the design section.

Participants. A total of 400 hundred participants from the United States (N = 199) and India (N = 201) were recruited to participate in this research study. The mean age was 32.78 (SD = 9.46).

Materials and Stimuli. The instrument used for this research was developed using Google Forms®, and participants were recruited for the study using Amazon's ® Mechanical Turk ® (MTurk). Although participants completing human intelligence tasks online in exchange for compensation has its limitation, the large convenient sample that is obtained outweighs several of the limitations of this methodology. In fact, studies by Buhrmester, Kwang, and Gosling (2011) and Germine, et al. (2012) both suggest that data collected on MTurk is as reliable as data collected in a traditional laboratory. Participants were asked to verify that they were at least 18 years of age, before being given the instructions for the questionnaire. Participation was voluntary, and no identifying information was collected from the participants. Once they completed the questionnaire, they were given instructions on how to redeem the compensation.

Procedure. In the questionnaire, two independent samples of participants were posed with two hypothetical scenarios. The first sample was presented with the following scenario, and was considered the control condition.

"Imagine that you are flying on a 4-hour commercial airplane flight from one major city to another. Sometime during the flight, the pilot comes on the intercom and tells you the altitude of flight and how long it will be before you land."

The second sample was presented with the following scenario, and was considered the failure condition.

"Imagine that you are flying on a 4-hour commercial airplane flight from one major city to another. Sometime during the flight, the airplane starts descending significantly at a point you did not expect. Following this, the pilot comes on the intercom and says that he made an error, that they were not supposed to descend and will rectify the mistake. He says that there is no actual emergency and not to worry. The pilot then tells you the altitude of flight and how long it will be before you land."

The questionnaires asked the participants to rate their levels of trust in the five different human entities and the five different automated aids. Trust was measure on a 7-point Likert type scale from –3 to +3 (extremely distrust to extremely trust) with a neutral option of zero. Questions relating to the participants' feelings were also asked in an effort to measure affect. Before being dismissed, participants were lastly asked for demographic information.

Design

Stage 1. This stage uses an experimental design employing factorial ANOVAs on the affect and trust data sets. The two-way factorial ANOVA performed on the affect data sought to identify the differences in participant emotions regarding the scenarios between the two countries of origin. The IVs were country of origin, and Failure/Non-Failure of the human. The three-way factorial ANOVA (2x2x10) was performed on the trust ratings of the participants. The IVs in this analysis were country of origin, category of human entity/type of automated aid, and Failure/Non-Failure of the human. The trust ratings of the participants were used for the DV.

Stage 2. Stage 1 conducted an ANOVA with all five human entities and all five automated aids, including the pilot that had the failure. With the pilot performing erroneously (failure) it was expected to show decreased levels of participant trust. Therefore, a secondary analysis was conducted with the aim of separating out the negative influence of the decreased levels of pilot trust. In stage 2, the remaining four human entities were averaged into one rating, and the five automated aids were averaged into one rating. A new three-way factorial ANOVA (2x2x2) was conducted with this modified data set. The IVs were still country of origin, category of human entity/type of automated aid, and Failure/Non-Failure of the human, although the levels of the second IV were reduced to 2 instead of the initial 10. The DV was still the participants' trust ratings.

Stage 3. Lastly, four different mediation analyses were performed using the affect data to determine whether emotions (affect) mediated the effect. As in stage 2, the mediation analyses were conducted with the pilot that made the mistake (failure component) removed from the ratings. The four mediation analyses were American participants on human entities, American participants on automated aids, Indian participants on human entities, and Indian participants on automated aids.

All the stages of this study used interval scales of measurement for the DVs even though the data was ordinal, due to the values being assigned equal magnitude difference on the Likert type scale (Göb, McCollin, and Ramalhoto, 2007).

Results

Stage 1. To produce a single value describing the participant's overall trust in the situation, all the values of the trust questions were averaged into one. The same was done for the affect data. Eight Cronbach's Alpha tests were conducted for each as a measure of internal consistency. Cronbach's Alpha scores ranging from .87 to .94 were found for the affect data and trust data for both Indians and Americans in both the control and failure conditions. These instruments were used in a previous study that measured the SWT contagion effect (Mehta & Rice, 2016). The previous study being considered as a pilot study for the instrument along with these Cronbach's Alpha scores add support for the research instrument as being valid and reliable for use in this study's setting. A two-way ANOVA was conducted on the affect data, with Failure/Non-Failure of the automation, and Country of Origin of the participants as the factors. There was a main effect of Failure, $F(1, 396) = 203.323$, $p < .001$, *partial-eta squared* = 0.34. There was a main effect of Country, $F(1, 396) = 16.331$, $p < .001$, *partial-eta squared* =

0.04. These effects were qualified by a significant interaction between Failure and Country, $F(1, 396) = 28.849$, $p < .001$, *partial-eta squared* = .07. This suggests that the American participants were more extreme in their views towards failure condition as compared to their Indian counterparts. Figure 1 displays the affect data for both participant groups in both conditions.

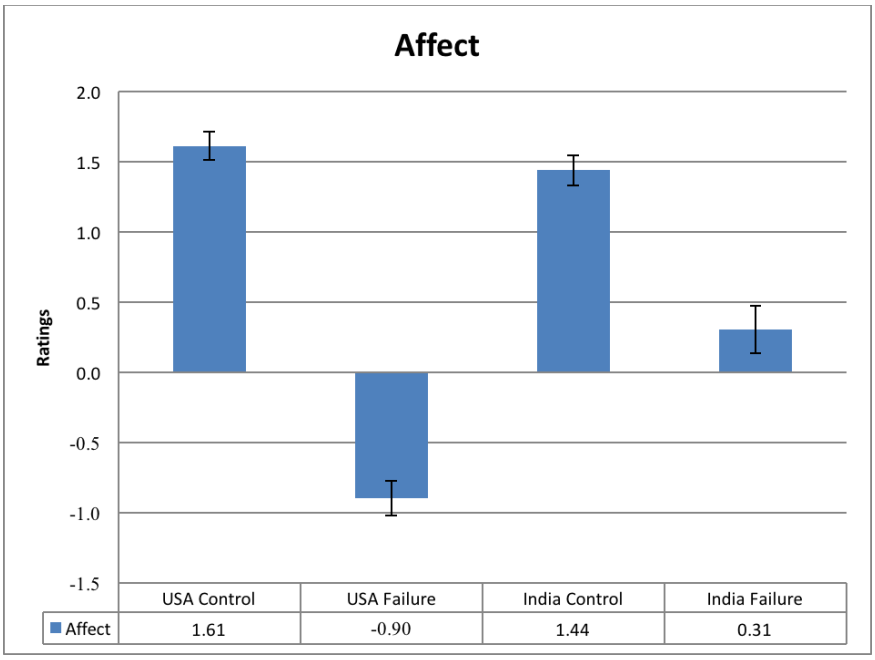
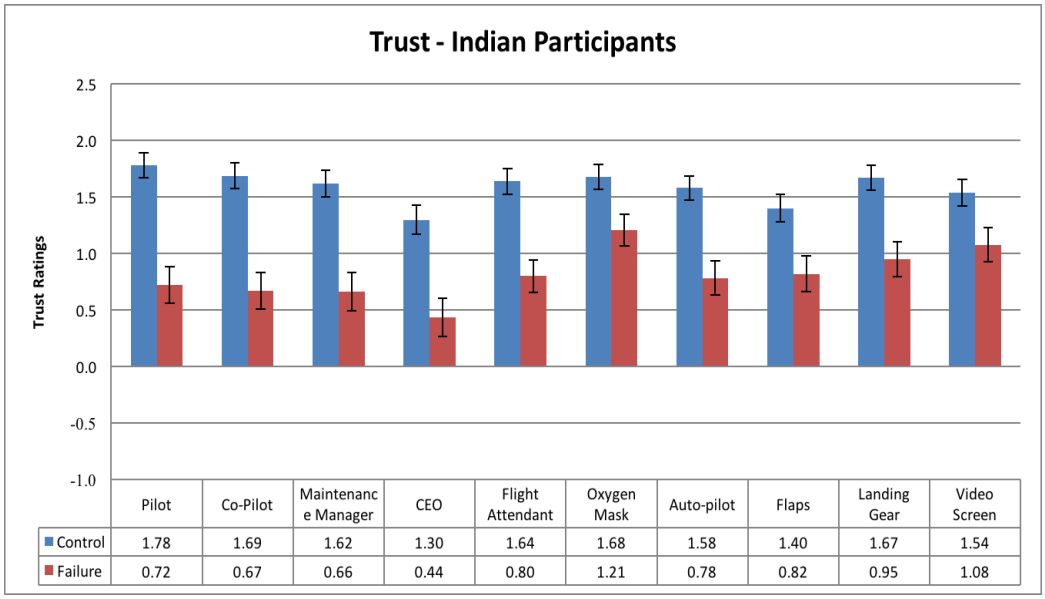


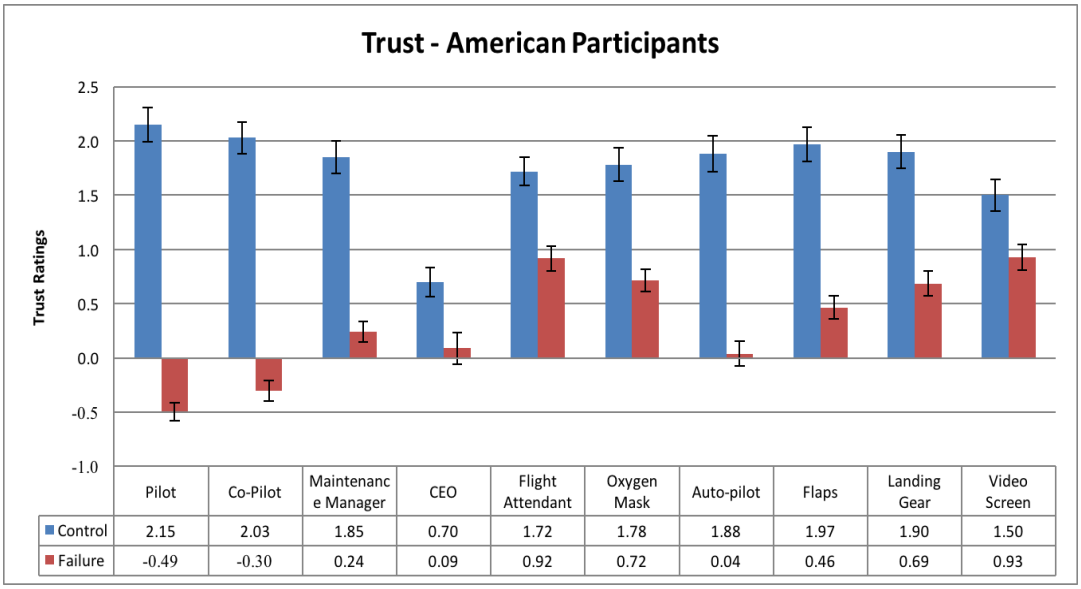
Figure 1. Affect Data for Indian and U.S. participants for Failure and Control Conditions.

A 2x2x10 ANOVA was conducted on the Trust data, with Type of automated device or category of human entity, Failure/Non-Failure of the automation, and Country of Origin of the participants as the factors. There was a main effect of Failure, $F(1, 396) = 107.981$, $p < .001$, *partial-eta squared* = .21. There were no other significant effects. There was a main effect of Type of automated device or category of human entity, $F(9, 396) = 23.413$, $p < .001$, *partial-eta squared* = .06; however, this effect was qualified by three significant interactions. The first was between items and country, $F(9, 396) = 5.508$, $p < .001$, *partial-eta squared* = .01. The second was between items and failure, $F(9, 396) = 25.125$, $p < .001$, *partial- eta squared* = .06. The final interaction was a three way interaction between items, country and failure, $F(9, 396) = 11.978$, $p < .001$, *partial-eta squared* = .03. Participants showed a significant decline in trust in both human entities and automated aids, suggesting the presence of SWT effect and a contagion effect. The trust data for the Indian and American participants are shown below in Figure 2 and Figure 3 respectively.



	Pilot	Co-Pilot	Maintenance Manager	CEO	Flight Attendant	Oxygen Mask	Auto-pilot	Flaps	Landing Gear	Video Screen
Control	1.78	1.69	1.62	1.30	1.64	1.68	1.58	1.40	1.67	1.54
Failure	0.72	0.67	0.66	0.44	0.80	1.21	0.78	0.82	0.95	1.08

Figure 2. Trust Data for Indian participants for Failure and Control Conditions.



	Pilot	Co-Pilot	Maintenance Manager	CEO	Flight Attendant	Oxygen Mask	Auto-pilot	Flaps	Landing Gear	Video Screen
Control	2.15	2.03	1.85	0.70	1.72	1.78	1.88	1.97	1.90	1.50
Failure	-0.49	-0.30	0.24	0.09	0.92	0.72	0.04	0.46	0.69	0.93

Figure 3. Trust Data for American participants for Failure and Control Conditions.

Stage 2. A 2x2x2 ANOVA was conducted on the Trust data, with Type of automated device or category of human entity, Failure/Non Failure of the automation, and Country of Origin of the participants as the factors. There was a main effect of Items, $F(1, 396) = 35.310$, $p < .001$, *partial-eta squared* = .08. This effect was qualified by an interaction between Items and Failure, $F(1, 396) = 7.46$, $p = .01$, *partial-eta squared* = .02. There was a main effect of Failure, $F(1, 396) = 92.939$, $p < .001$, partial-eta squared = .19 this effect was qualified by one significant interaction between Country and Failure, $F(1, 396) = 6.110$, $p = .01$, *partial-eta squared* = .02. There were no other significant effects.

This analysis suggested that the decrease in trust was still significant indicating the presence of the SWT effect and contagion effect with the effect of the human pilot removed from

the analysis. Figure 4 shows the trust averages for both the Indian and American participants on the four Human entities and the five automated aids.

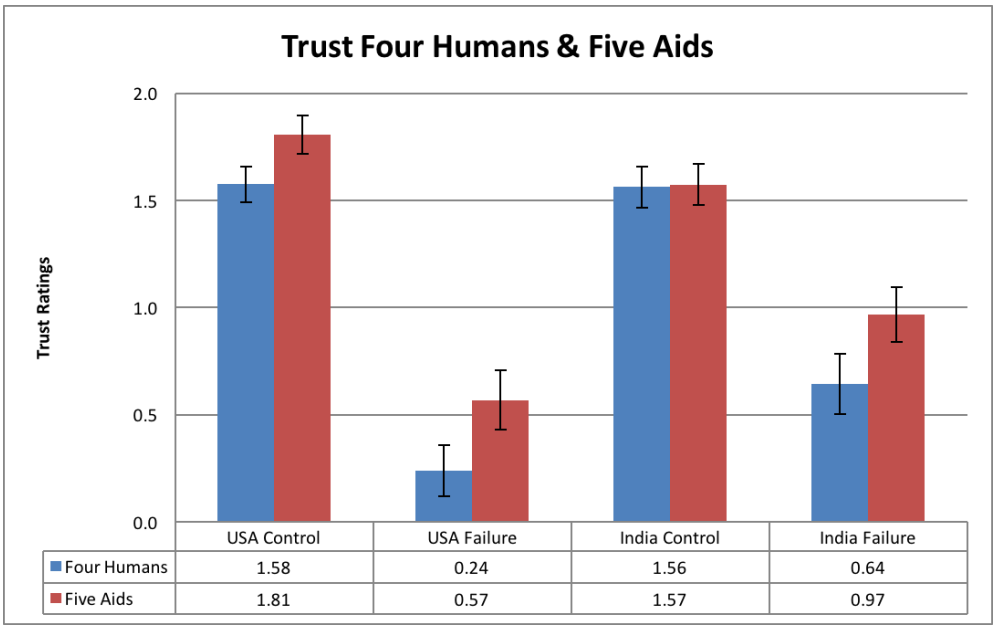


Figure 4. Trust data on the four human entities and the five automated aids.

Stage 3. The first mediation analysis was conducted using American participants to compare the failure condition to the non-failure condition with respect to their feelings towards the human entities. The paths for this mediation analyses can be found in Figure 5A. In order to conduct the mediation analysis, the correlation between Condition and Trust was first found to be significant, $r = -.552$, $p < .001$, showing that the initial variable correlated with the outcome variable. The standardized path coefficients were: condition to affect ($\beta = -.749$, $p < .001$); affect to trust ($\beta = .714$, $p < .001$); condition to trust controlling for affect ($\beta = -.017$; $p = .819$). These data show that Affect mediated the relationship between Condition and Trust.

The second mediation analysis was conducted using American participants to compare the failure condition to the non-failure condition with respect to their feelings towards the automated aids. The paths for this mediation analyses can be found in Figure 5B. In order to conduct the mediation analysis, the correlation between Condition and Trust was first found to be significant, $r = -.475$, $p < .001$, showing that the initial variable correlated with the outcome variable. The standardized path coefficients were: condition to affect ($\beta = -.749$, $p < .001$); affect to trust ($\beta = .598$, $p < .001$); condition to trust controlling for affect ($\beta = -.027$; $p = .753$). These data show that Affect mediated the relationship between Condition and Trust.

The third mediation analysis was conducted using Indian participants to compare the failure condition to the non-failure condition with respect to their feelings towards the human entities. The paths for this mediation analyses can be found in Figure 5C. In order to conduct the mediation analysis, the correlation between Condition and Trust was first found to be significant, $r = -.357$, $p < .001$, showing that the initial variable correlated with the outcome variable. The standardized path coefficients were: condition to affect ($\beta = -.373$, $p < .001$); affect to trust ($\beta =$

.619, $p < .001$); condition to trust controlling for affect ($\beta = -.126$; $p = .026$). These data show that Affect mediated the relationship between Condition and Trust.

The fourth mediation analysis was conducted using Indian participants to compare the failure condition to the non-failure condition with respect to their feelings towards the automated aids. The paths for this mediation analyses can be found in Figure 5D. In order to conduct the mediation analysis, the correlation between Condition and Trust was first found to be significant, $r = -.261$, $p < .001$, showing that the initial variable correlated with the outcome variable. The standardized path coefficients were: condition to affect ($\beta = -.373$, $p < .001$); affect to trust ($\beta = .549$, $p < .001$); condition to trust controlling for affect ($\beta = -.056$; $p = .373$). These data show that Affect mediated the relationship between Condition and Trust.

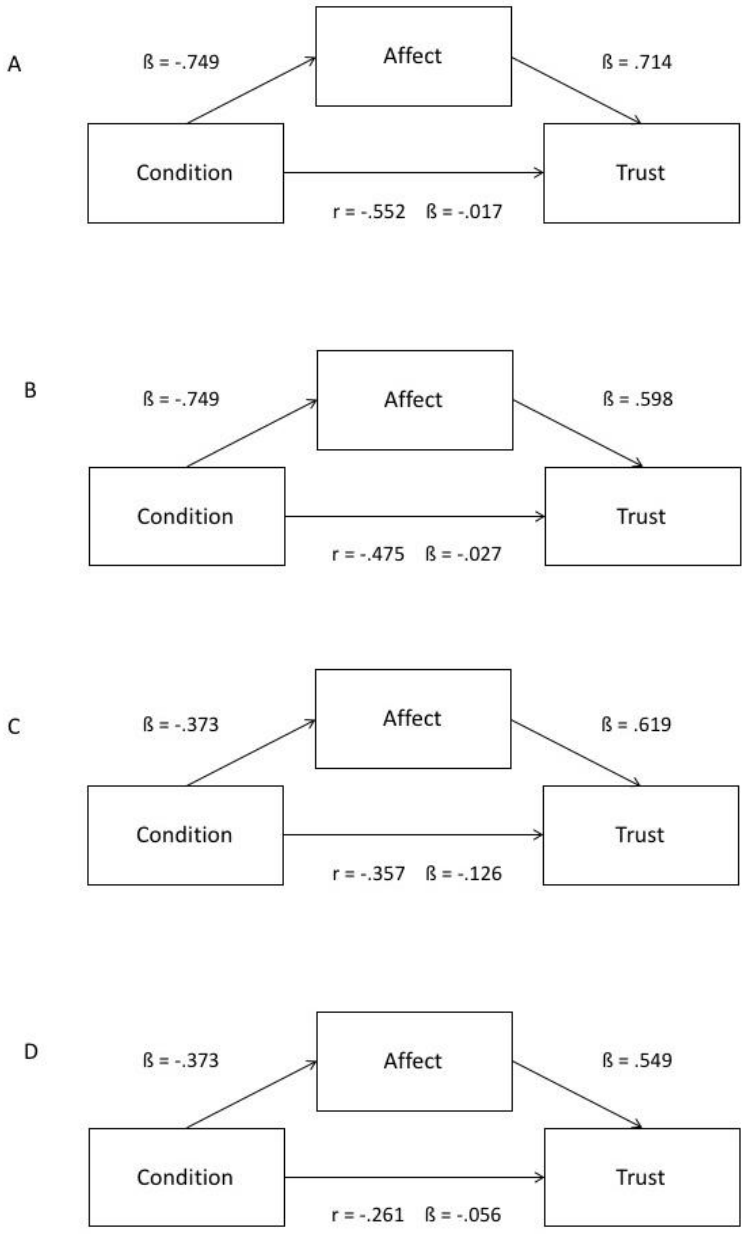


Figure 5. Paths for Mediation Analyses

General Discussion

The aim of this study was to determine if the SWT Contagion Effect, investigated by Mehta and Rice (2016), was applicable in a reverse contagion scenario wherein participant trust in system components was measured following a failure in a member of the flight crew as opposed to an automated system. Research findings support all the research hypotheses.

The first research hypothesis predicted that there would be a fall in trust in unrelated automated aids or unrelated human entities following the failure of a flight crew member as compared to the control condition. This proposition is supported by both stages of the data analysis. In Stage 1, findings depict significant decreases in passenger trust in all categories across both countries. Stage 2 data analysis depicted statistically significant decreases in passenger trust having removed the effect of the failed component from the analysis. This consistent decrease in passenger trust is evident of the existence of a reverse contagion effect. While the decrease in trust for other unrelated human entities is consistent with the findings of Mehta and Rice (2016), the decrease in trust in unrelated automated aids, while expected, is of particular interest. This decrease illustrates that SWT theory holds regardless of whether the failed entity is human or automated. Furthermore, it validates aforementioned research which establishes passenger trust in human operators, due to a perceived sense of human reliability, adaptability and flexibility.

The second research hypothesis predicted that trust and affect ratings for the unrelated automated aids or human entities would differ as a function of country of origin. To this end, the analyzed dataset depicts a lesser decrease in trust in the failed condition from Indian participants as compared to their American counterparts. These differences may be attributed to be the result of the significant cultural differences between the two countries as established by the analysis of Hofstede's (1984) cultural dimensions and their associated indexes. Of note are the ratings which depict India as being significantly more collectivistic and having a lower Uncertainty Avoidance. These prevailing qualities may be said to be conducive to the creation and prevalence of a generally more trusting society which manifests as smaller decrease in trust in a failed condition among Indians when compared to the decreases in trust by American respondents.

The third research hypothesis predicted that the condition and trust would be mediated by affect. To this end, the data analysis confirmed the hypothesis thereby establishing that the responses of survey participants were influenced by emotions rather than logic. This is consistent with the affect heuristic which establishes that, while emotion may not lead to the making of a bad decision, the decision-making process of an individual is based largely on the emotional response of that individual to, in this case, the failure condition. Consistent with the findings of Mehta and Rice (2016), the data also establishes that, while changes in passenger trust may differ between cultures, the responses of participants from both cultures were influenced by emotion.

The forth research hypothesis purported a non-directional prediction that there would be some interaction between the independent variables. Results also support this hypothesis as the fluctuations in passenger trust were qualified by interactions between the system component and the national culture, the system component and the failure condition, and the three-way

interactions between system components, national culture and the failure condition. This too is consistent with the findings of Mehta and Rice (2016).

Limitations and Practical Implications

Any research work that is carried out has some restrictions. This study also has some limitations, and they have been well identified. The primary limitation is the data collection technique and methodology used. To achieve large samples sizes, the use of an online data collection source such as Amazon's ® Mechanical Turk ® (MTurk) is necessary, however in turn, this takes part of the control of the environment away from the researcher. While the data collection method allowed for a collection of large convenient samples, the generalization of the results is limited to just two countries. Therefore, the findings can only be applied to passengers in the United States and India and not all passengers around the globe.

Another limitation is the target participants. The study includes aviation consumers and non-aviation consumers—including those who may have never flown in an aircraft before. The rationale for this inclusion is that even though participants may not have flown on a commercial airline before, they may do so in the future and therefore can be considered potential future consumers. Additionally, the convenience sample including participants that have never flown on an airliner is beneficial to the sample size of the study, and is therefore an acceptable limitation. When conducting a study involving multiple stages of data analysis, a large sample size is required which comes with its own limitations, some of which are acceptable. Along with these limitations comes the limitation of the participants self-reporting levels of trust. Future research may seek to utilize a different means of studying participant trust that would be more free of bias, but for the purpose of this study to replicate the methodology of Mehta and Rice (2016), the same measurements of trust were incorporated.

Despite the limitations, the value of the study to the scientific community and the practical benefits to the aviation industry cannot be understated. Similar to the previous study in this context (Mehta & Rice, 2016), the practical implications of these findings is one of passenger understanding which could have significant financial consequences to the airline industry. Decreased trust in the airline system, the upper echelon of management (CEO) and in the industry as a whole could arise out of a failure of the human pilot.

It is important to understand these findings as failures in human pilots does not bring about an increase in trust in the automation. This is the most significant finding and practical contribution of this study. Had there not been the existing of this reverse contagion effect or rather a positive contagion effect (human failure leading to increased trust in automated components of the system), it could have indicated the turning of the tides to passengers' acceptance of more automated aircraft. The findings of this study show this not to be the case, and that knowledge is in fact value to aviation industry as it plans for the future with new more advanced automation in aircraft.

These findings could also be of use to industries outside of aviation, showing the human failure could have a negative contagion effect onto other independent components of the system.

Lastly, this study serves to revalidate the concept of the system wide trust theory as a whole by adding further evidence of its existence.

Future Work

The primary source of future research will be the replication of this study. It is hypothesized that the reduction of the contagion effect of human failure onto automated aids would indicate a change of perception to the increase in automation that controls airliners. If replication studies find a positive contagion of human failure resulting in an increase in passenger trust in automated aids, it could be a sign of acceptance towards completely automated aircrafts.

Previous studies have been mainly focused on the aviation industry, but as the wave of automation is slowly taking over other industries, this study could be carried out in those realms as well. Additionally, this study can be used as a foundation for understanding the mindset of participants in other fields that have started using automation as a method to improve their service or improve their products. Studies in similar fields can greatly help understand the effects and differences in trust and what failures affect consumers' trust. Future work should also be focused on removing the limitations that were present in this study. For example, including participants from more countries would serve to identify whether the reverse contagion effect is localized or a globally-observed phenomenon.

Conclusion

This study supports the theory that a System Wide Trust (SWT) reverse contagion effect does exist from human to automation in an aviation setting. Previous aviation studies have focused on the application of SWT Theory to pilot perceptions of independent automated aids. The purpose of this study was to determine if there was a reverse contagion effect wherein airline passenger trust in automated system components was affected by an error in a human system element. This was measured by examining passenger's level of trust after a flight crew member makes an unintentional mistake, or failure. Trust was measured in five human entities and five automated aids. In order to determine the significance of culture in the application of SWT in a reverse contagion scenario, this study was inclusive of a cross-cultural analysis with participants from both the United States and India. The research findings supported all the hypothesis, including a decrease in trust in unrelated automated aids, a difference in trust as a function of country, a mediation effect between the condition and trust, and an interaction between the independent variables. The most significant finding and practical contribution of the study is that the pilot failure (mistake) does not cause an increase in the passenger's trust in automation. This implies that passengers are not yet ready to accept more automated aircraft, such as unmanned aircraft.

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