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Comparing the Distraction of Cell Phone Conversations to In-Person Conversations on a Simulated Commercial Flight

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Cover Page Footnote

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On July 6, 2013, a Korean registered Boeing 777-200ER flying as Asiana Airlines Flight 214 struck a seawall at San Francisco International Airport (SFO) when approaching the runway. Three of 291 passengers were fatally injured. Two of these three passengers were ejected from the airplane immediately after the impact. The reason why the passengers were ejected was that they were not wearing seatbelts during the impact (Aarons, 2014). Brown (as cited in Davies, 2013) states that several passengers are injured from turbulence in the United States every year while they are not wearing seatbelts, and a few people's injuries have proven fatal. It may not be intentional that passengers are not complying with fastening seatbelts when required to do so, rather it may be due to being distracted when announcements or other safety instructions are presented.

Undoubtedly, personal conversations could be a factor that has a considerable effect on passengers' attention to the announcements. Although passengers are free to talk to other passengers at any time during a commercial flight, cell phone conversations are prohibited. According to Title 47 of the Code of Federal Regulations (47 CFR) part 22, § 22.925, the Federal Communications Commission (FCC) prohibits the use of cell phone while the aircraft is airborne (Telecommunication, 2018). They regulated that cell phone use is not allowed on aircraft in the air unless the airplane is equipped with a device that enables control of onboard mobile devices and eliminates the interference between ground-based cellular stations with airborne cellular devices. In other words, if the aircraft is equipped with new specialized onboard equipment, then the cell phone ban is not applicable to the aircraft. Moreover, the Department of Transportation (DOT) stated that the FCC's current regulations are not effective for the communications via Wi-Fi. The FCC has not prohibited the use of voice communication technologies, such as Skype, Apple FaceTime, and Google Hangouts on planes (Zhang, 2016). Using these devices, passengers are actually allowed to make voice calls, which are similar to regular phone calls, on commercial airliners. In addition, the DOT announced that the FCC has considered lifting the ban (Zhang, 2016).

Due to new technology, the European Union (EU) planned to allow passengers to make phone calls over base stations located on the airplanes once the airplane reaches 3,000 meters ("European Union Approves," 2008). This new technology, the Picocell, is a low-powered operator-deployed base station, and it has the ability to improve the coverage of hot spots and cell edge with a 10-200 m radius (Kumar, Kalyani, & Giridhar, 2015; Wu, Murherjee, & Ghosal, 2004). This technology prevents transmission from reaching the ground and eliminates the interference with the ground network (Lopano, 2011). It makes the in-flight phone calls possible. Thanks to the Picocell, new EU rules and conditions have been established to allow commercial flight passengers to make phone calls in the air.

Expectedly, this new passage may pave the way for considering lifting cell phone bans in the United States.

If the ban is lifted, it is important to understand to what extent passengers talking on cell phones would be distracted from safety instructions. Usually, flight passengers tend to be occupied with something that interests them (e.g., reading books, listening to music, and talking with other passengers) during flights, especially during long trips. However, people do not have the capacity to efficiently multitask (Lien, Ruthruff, & Johnston, 2006). Lien, Ruthruff, and Johnston stated that accuracy and response time were two important measures of people's performance when they conducted dual-tasks. They argued although sometimes dual-task behavior did not lead to an error, it led to response delays instead. That is because people tend to pause when they are engaged in another task, consequently causing response delays. In actuality, most people do not conduct two tasks simultaneously. Endsley and Jones (2011) maintain when people are dealing with more than one task, they have to pay frequent attention to different tasks according to their importance or rate of change. In this case, they need to allocate attention based on priority. Sheridan (2007) defined the attention allocation as "a form of decision behavior that depends heavily on stored information . . . about objects and events with respect to their interrelationships in time, space, magnitude, and relevance" (p. 17), and it decides what things that mental resources should be focused on. For flight passengers, if there is an external stimulus, such as an announcement or an abnormality, passengers will pay attention to both their conversations and the external stimulus. Under this situation, passenger's attention to the most important task, which is the external stimulus, will be impaired.

Admittedly, sometimes flight attendant may walk around and remind passengers of announced safety instructions, such as fastening seatbelts, putting tray tables back, and adjusting seat backs, but passengers cannot merely rely their safety on this. Damos, Boyett, and Gibbs (2013) addressed flight attendants had three categories of duties, which were safety, security, and passenger service, and they can hardly perform each safety and security duty with compliance to airline standards in time. Reminding passengers of safety instructions is one of the safety duties. In other words, passengers need to be aware of safety announcements to ensure their own safety. Therefore, as a passenger, maintaining situation awareness (SA) is important. SA occurs at three levels, where an individual perceives stimuli and changes in the environment, can make sense of that information, and can use that information to predict what will occur in the future (Endsley & Jones, 2011). Passengers need to be aware of changes to cabin status (cabin service, emergency situations, etc.). Although several SA studies have been conducted in the aviation industry, studies of passenger SA are infrequent. When passengers are focusing on

cell phone conversations, they have to conduct dual tasks to listen to flight announcements while conversing on cell phones. In this case, there is more than one thing that passengers need to pay attention to, and passengers may become less aware of the information. Consequently, the passenger may miss important instructions that affect their safety.

Although few studies demonstrated that cell phone use affects flight passengers' attention, a significant amount of research has demonstrated that cell phone use during driving has a significantly negative influence on driving performance. Drivers using cell phones pay less attention to traffic, less attention to signals, and have slower reaction time, poorer memory of roadside objects, and negative effects of other driving critical issues (Strayer, Drews, & Johnston, 2003). Redelmeier and Tibshirani (1997) concluded that in nearly 24% of car accidents, drivers had used cell phones within a 10-minute period prior to the accidents. When drivers use cell phones while driving, the likelihood of being involved in a car accident increases by a factor of 3. Redelmeier and Tibshirani also asserted that the person who uses a cell phone while driving behaves the same as a person who drives with a blood alcohol level above the legal limit. Furthermore, Strayer and Johnston (2001) concluded that engaging in cell phone conversations largely increases the likelihood of missing traffic signals. Although some cell phone users succeeded in noticing the traffic signals, they still took longer to respond to red lights. Strayer et al. (2003) investigated that cell phone conversations impaired the reactions of drivers to frontal vehicles braking. Although legislators attributed the poor performance in driving to dialing and holding phones, the probable cause of poor driving performance is the distraction from driving caused by conversations (Strayer & Johnston, 2001; Strayer et al., 2003). Therefore, it is possible that in-flight cell phone conversations impair passengers' performance in the cabin as well.

Obviously, in-flight face-to-face conversations are allowed on commercial flights; however, it is uncertain that whether the cell phone conversations have a more considerable influence on distracting passengers' attention when compared with the face-to-face conversations. For drivers, conversing on cell phones is unlike conversing with passengers in the car. Passengers who sit in the car are aware of the driving situation. They will modify their conversations (e.g., stop the conversation) according to surroundings and traffic situation. Similarly, in the cabin, when one passenger is conversing with another passenger, that passenger may modify the conversation under different situations; by contrast, when the passenger is conversing on the cell phone, the person on the other side of the phone does not know the situation in the cabin and will not modify the conversation. However, drivers are different from the passengers in the cabin. Drivers are active, and they control the vehicles; on the contrary, passengers are inactive because they

do not know the situation outside the aircraft, such as turbulence. Nevertheless, it is simply an assumption generated from the studies about drivers that cell phone conversations have a greater influence on passengers' attention to safety instructions than face-to-face conversations.

The purpose of this study was to test this hypothesis. The research was conducted to identify the extent to which passengers talking on cell phones are distracted from cabin announcement and action requests (e.g., raise tray table) compared to passengers talking with an adjacent passenger and to passengers who are not involved in conversations on a simulated commercial flight.

Method

Sample and Population

The target population of this study included commercial airliner passengers in the United States. Fifty-two participants (38 male, 14 female) volunteered for this study. They were enrolled at the Embry-Riddle Aeronautical University in Florida, and they included undergraduate, master, and Ph.D. students. The mean age of the participants was 20.79 years (SD = 2.73). The minimum age was 18, and the maximum age was 30. To reduce the individual differences, requirements for participation included fluency in English, and all participants stated they had flown on a commercial flight within recent memory. Participants self reported to have normal hearing abilities.

Participants were randomly assigned to one of three groups: the cell phone conversation group, the face-to-face conversation group, and the control group. Three participants from each group were randomly selected for each of the 18 sessions. However, for two sessions, one of the participants did not show up. Consequently, there were only two experimental groups, the cell phone conversation group and the face-to-face conversation group, for these two sessions. Therefore, 18 participants were in the cell phone conversation group; 18 participants were in the face-to-face conversation group; and 16 participants were in the control group.

Experimenters and Confederates

There were three confederates that pretended to be participants in the experiment, and there were two experimenters. During each session, one experimenter sat in an adjacent room and conversed with the participants in the cell phone conversation group. One confederate sat next to the participant in the face-

to-face conversation group and conversed with them face to face. The other two confederates were seated next to the participants to observe participants' behaviors and record data. Another experimenter played the role of a flight attendant and stood behind the seats. The flight attendant also observed participants.

Materials

Seats. Twelve aircraft seats, arranged in two rows, were set up in a laboratory room to simulate a commercial aircraft cabin. The seats were equipped with seatbelts and tray tables. For the purpose of ensuring that participants could use seatbelts and tray tables, only the seats in the back row were utilized. The seat layout is shown in Figure 1. Group seating positions were counterbalanced across the seats. To minimize the influence of crosstalk, participants in the cell phone conversation group and the face-to-face conversation group were always seated on opposite side of the aisles (see Figure 2).

Speaker. A mechanical speaker was placed in the front of the room to play the announcements. The speaker was able to connect with a cell phone by Bluetooth. The experimenters were able to control the speaker from outside the room.

Announcements. There were three pre-recorded simulated in-flight announcements that were played during the experiment. The first announcement was a general in-flight announcement. It provided in-flight meal information and in-flight entertainment information. The second announcement was an emergency announcement, which was about a potential engine failure. The final announcement stated the engine problems had been resolved, and it was also the sign of the end of the simulation.

<table>
<tr><td>(Empty)</td><td>(Empty)</td><td>(Empty)</td><td rowspan="2">Aisle</td><td>(Empty)</td><td>(Empty)</td><td>(Empty)</td></tr>
<tr><td>Participant Or Confederate</td><td>Participant Or Confederate</td><td>Participant Or Confederate</td><td>Participant Or Confederate</td><td>Participant Or Confederate</td><td>Participant Or Confederate</td></tr>
<tr><td colspan="7">Experimenter (Flight Attendant)</td></tr>
</table>

Figure 1. Seat layout.

Sessions	Left Side			Aisle	Right Side		
1, 7, 13	Face-to-face Group observed by Flight Attendant	Confederate Conversing with Face-to-face Group	Confederate A	Aisle	Cell Phone Group observed by Confederate A	Control Group observed by Confederate B	Confederate B
2, 8, 14	Control Group observed by Flight Attendant	Confederate Conversing with Face-to-face Group	Face-to-face Group observed by Confederate A	Aisle	Confederate A	Cell Phone Group observed by Confederate B	Confederate B
3, 9, 15	Cell Phone Group observed by Flight Attendant	Confederate A	Control Group observed by Confederate A	Aisle	Confederate B	Face-to-face Group observed by Confederate B	Confederate Conversing with Face-to-face Group
4, 10, 16	Confederate B	Control Group observed by Confederate B	Cell Phone Group observed by Confederate A	Aisle	Confederate A	Confederate Conversing with Face-to-face Group	Face-to-face Group observed by Flight Attendant
5, 11, 17	Confederate B	Cell Phone Group observed by Confederate B	Confederate A	Aisle	Face-to-face Group observed by Confederate A	Confederate Conversing with Face-to-face Group	Control Group observed by Flight Attendant
6, 12, 18	Confederate Conversing with Face-to-face Group	Face-to-face Group observed by Confederate B	Confederate B	Aisle	Control Group observed by Confederate A	Confederate A	Cell Phone Group observed by Flight Attendant

Figure 2. Seating configuration by session.

Stopwatch. Three stopwatches were used to measure participants' time to initiate responses (i.e., lower the tray table, raise the tray table, and visibly check and fasten the seatbelt). During the experiment, two confederates who sat beside participants and pretended to be playing games on an electronic device, recorded the time. The experimenter, who played the role of the flight attendant, stood behind all participants and used a stopwatch to record the time.

Video recorder. A video recorder was mounted on the ceiling of the room. It took video recordings of the simulation. When collecting data, the time that experimenters and confederates measured with stopwatches and the time that the videos recorded were checked against each other to ensure that collected response times were accurate.

Conversation script. The confederate who talked with participants face-to-face and the experimenter who was conversed with participants on a cell phone followed a script to stimulate dialogue during the simulated flight. The script included questions about the participants' background information (e.g., how many classes they were enrolled in this semester, what their majors were, where they were from).

Comprehension test. Ten questions were developed to test participants' comprehension of the information provided in the announcements. Five questions were from the general in-flight announcement, and five questions were from the emergency announcement. However, during the experiment, it was found that one question from the emergency announcement had an influence on participants'

compliance with the announcements. The answer to this question instructed participants to assist any passengers seated next to them. In this case, some participants reminded other participants who did not initiate responses to comply with the instructions. Therefore, the question was removed, and data analysis only included four questions that were about the emergency announcement.

Group Instructions. All three groups were asked to obey all current in-flight regulations and to assume that cell phone calls were permitted. The participants in the cell phone conversation group were told to assume that they would receive a phone call from an acquaintance and asked to engage in the conversation. The face-to-face conversation group was instructed to assume that passenger next to them was a friend who was traveling with them and would start a conversation with them. The control group was allowed to do anything they would like to do (as per FAA regulations) except use a cell phone or make conversations with any other people. Participants were also asked to listen to and adhere to the information provided in the announcements.

Procedure

This experiment was a 3 x 2 mixed design. The between-subjects variable was the group membership (cell phone conversation, face-to-face conversation, and control). The within-subjects variable was the type of the announcements, which included emergency and general in-flight announcements. Before each experimental session, instructions were read to each participant, as per an instruction sheet. After the simulation had started, the dialogue between confederates and participants began and continued to the end of the session. The cell phone conversation group talked with a confederate who was positioned in an adjacent room. The face-to-face conversation group conversed with the passenger next to them. The control group did not talk on the phone or with an adjacent passenger. The general in-flight announcement started playing during the first minute of the session. During the general in-flight announcement, all passengers were asked to lower their tray tables as soon as practical, so the flight attendants would be able to serve dinner quickly. The emergency announcement started playing during the third minute of the session. During the emergency announcement, all passengers were instructed to raise the tray tables immediately and then physically check that their seatbelts were fastened and tightened. The experimenter who played the role of flight attendant reminded participants to lower tray tables if they had not done so 40 seconds after it was requested. This reminder was to assure that all tray tables were down before the subsequent emergency announcement directed the passengers to put the tray tables up.

The experimenter and the confederate who conversed with participants were asked to follow the participants' lead. For example, the confederate in the face-to-face conversation group would only raise the tray table if the participant raised the tray table first. If the participant interrupted the conversation to listen to the announcement, the confederate would respond to the participant's request. The purpose was to give participants the power of decision and see if they were willing to attend to announcements. Soon after the emergency announcement was played, a final announcement was played saying that the emergency has been resolved. Immediately after this last announcement was played, participants were told that the simulation had ended. The experimenter who acted as a flight attendant and those two confederates who sat next to participants observed participants' behaviors, and they noted whether or not participants complied with instructions and how long it took each participant to initiate responses. Predetermined behaviors included the instructions that were stated in the announcements (i.e., lowering tray tables, raising tray tables, and visibly checking seatbelts).

Once the simulation ended, each participant was given the 9-item comprehension questionnaire to complete. These questions asked participants to recall specific information in the general in-flight announcement and the emergency announcement. The comprehension test did not include any questions about the final announcement and the conversations with the confederates. The number of questions that each participant correctly answered was measured to determine participants' retention of the announcements.

Results

Participants' Compliance with Instructions

The percentages of the participants who complied with announcement instructions for each group are shown in Table 1. Pairwise chi-square tests for independence were conducted for each compliance variable to determine the relationship between participants' compliance with the instructions and the groups they were in. For lowering the tray table instruction, a pairwise chi-square test showed the cell phone conversation group was less likely to comply with lowering the tray table than the control group, χ^2 (1) = 4.250, p = 0.039 (φ = 0.354). The face-to-face conversation group was less likely to comply with raising the tray table than the control group, χ^2 (1) = 5.211, p = 0.022 (φ = 0.391). The face-to-face conversation group was less likely to fasten and tighten their seatbelt than the control group, χ^2 (1) = 4.859, p = 0.028 (φ = 0.378). No other significant results for compliance with instructions were found.

Table 1

Descriptive Statistics of Participants' Responses

Instructions	Phone (%)	Face-to-Face (%)	Control (%)
Lowering Tray Table	33.33	38.89	68.75
Raising Tray Table	94.44	72.22	88.89
Fastening Seatbelt	61.11	44.44	68.42

Note. Phone = Cell Phone Conversation Group, Face-to-Face = Face-to-Face Conversation Group, Control = Control Group

Participants' Reaction Time

The time was recorded from when the action keyword played (i.e., put down your tray tables, put tray tables back, and make sure your seatbelt is fastened and tightened) to when the participant complied with the demand. The mean reaction time, standard deviation, minimum time, and maximum time to comply for each instruction are shown in Table 2. To test the difference in reaction time between the groups for each instruction, one-way between-subjects Analysis of Variance (ANOVAs) were run. The results showed no significant difference in reaction time between groups.

Table 2

Reaction Time for Each Instruction in Seconds

	Mean	*SD*	Minimum	Maximum
Lowering Tray Table	7.50	6.30	0.32	25.81
Raising Tray Table	4.27	3.94	0.02	17.96
Fastening Seatbelt	8.12	6.73	1.03	25.38

Note. *SD* = Standard Deviation

Participants' Retention of Announcements

The participants' retention of announcements was assessed according to the proportion of the questions about the announcements they answered correctly. A 3 (group: cell phone conversation, face-to-face conversation, control) x 2 (announcement: general in-flight, emergency) two-way mixed ANOVA was conducted on retention of announcements. The results showed a significant main effect of group, $F(2, 49) = 6.908$, $p = .002$, $\eta^2 = 0.220$. Bonferroni post-hoc tests were run. The control group was significantly better than both the phone

conversation group and the face-to-face conversation group (See Figure 3). The results also revealed a significant main effect of announcement, $F(1, 49) = 9.692$, $p = .003$, $\eta^2 = 0.165$. Retention of the questions about the emergency announcement was greater than the retention of the questions about the general in-flight announcement. No significant group x announcement interaction was found, $F(2, 49) = 2.416$, $p = .100$, $\eta^2 = 0.090$.

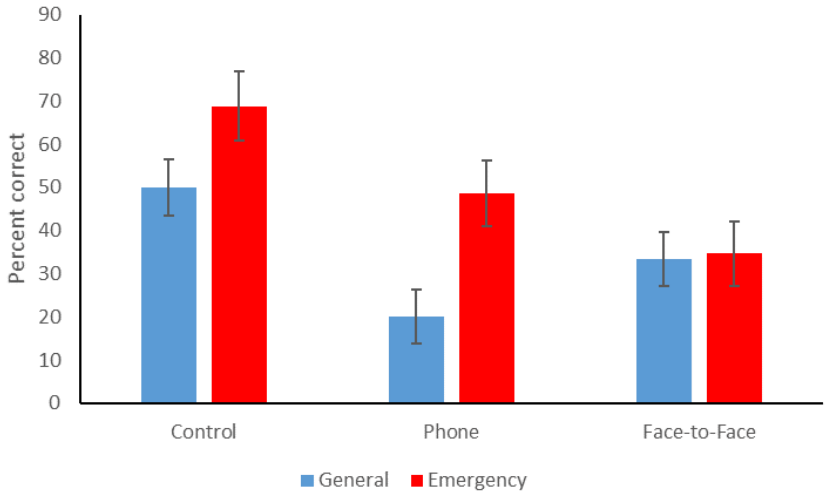

Figure 3. Recall accuracy by group and type of announcement.

Discussion

Compliance with Instructions

For the compliance with the instructions from the announcements, the control group never performed worse than the cell phone conversation group or the face-to-face conversation group. The control group was more likely to comply with the lowering tray table than the cell phone conversation group, and the control group did better on complying with the raising tray table instruction and checking seatbelts than the face-to-face conversation group. One reason for this better performance could be the control group was not involved in conversations; therefore, they were not distracted by conversations.

Nevertheless, when comparing the cell phone conversation group with the face-to-face conversation group, there was no significant difference in participants' compliance with any instruction. These two groups always performed equally poor when compared to the control group. Strayer et al. (2003) showed that drivers on cell phone conversations performed worse in comparison to the drivers conversing with passengers in the car. A reason could be that drivers are the operators of the

vehicles, and they are aware of the traffic situations. By contrast, the flight passengers in the cabin have a limited view of the surroundings of the airplane, and obviously are not actively controlling the airplane. A probable reason to explain why there was no difference between the face-to-face group and the cell phone group was that although the passengers who were conversing face-to-face with the other passengers, those passengers had to look at each other, so they have selected attention on the conversation. Thus, the passengers who were involved in cell phone conversations may have the ability to perceive more information about their surroundings than the face-to-face group.

Reaction Time

The results did not show any differences in the reaction time among three groups. However, many participants did not initiate responses to these instructions. Only the reaction time of the participants who complied with the announcement instructions was used for the data analyses. Consequently, the numbers of reaction time data dramatically decreased. Therefore, low experimental power may be an explanation why differences between groups were not found.

Retention of Announcements

As for the retentions of the announcements, participants' performance was determined by groups and the type of the announcement, but there was no interaction between the group and the announcement. Among the groups, the control group correctly answered more questions about the announcements than either of the other groups. There were no differences in the proportion of the questions recalled between the face-to-face group and the phone group. It showed that the distraction caused by cell phone conversations was the same as the distraction caused by face-to-face conversations. In other words, the extent to which participants listened to and remembered the announcements when talking on a phone was similar to the extent to which participants listened to and remembered the announcements when conversing face-to-face.

Furthermore, participants recalled more information about the emergency announcement than the general in-flight announcement. A probable reason was that the word "emergency" was a trigger, and when people heard this word, they tended to focus more on the announcement.

Limitations

A limitation of this experiment was the short duration of the simulation. Each session lasted for 5 minutes. Longer sessions would permit more announcements and greater length of conversations. Another limitation was this experiment did not take other passengers' distraction and annoyance with in-flight cell-phone conversations into consideration. As Jansen (2017) reported, the DOT received thousands of comments that requested a ban on in-flight voice calls. Further research may be needed to discover passengers' attitudes toward in-flight phone calls.

Conclusions

The purpose of this study was to determine the difference in participants' attention to announcements when talking on a cell phone versus when talking face-to-face. Participants' attention were tested by two measures. One measure was to observe participants' compliance (response to the instructions that were stated in the announcements), and the other one was to test their retention of the announcements. The results showed that no significant differences between the cell phone conversation group and the face-to-face conversation group in any of these measures. The control group, unsurprisingly, did better than the other two groups on several of the measures. Additionally, participants had greater retention of the emergency announcement than the general in-flight announcement.

One important finding was that engaging in cell phone calls was no worse (as it relates to compliance and announcement recall) than engaging in a face-to-face conversation. Although cell phone conversations had been demonstrated to have adverse effects on passengers' attention to in-flight announcements, it appeared no worse than the adverse effects on passengers' attention to the in-flight announcement when engaged in a conversation with an adjacent passenger. The ban on in-flight cell phone calls does not seem to improve flight safety in regards to passengers' attention, when compared to other passengers who are conversing with adjacent passengers. Therefore, the ban may not be necessary. Additional studies that may corroborate these findings are warranted. Similar findings may support consideration for lifting the bans on cell phone calls for commercial flight passengers.

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