In addition, the team that performed the psychoacoustical analysis went to Dallas to witness the live firing in Dealey Plaza described earlier here today.

The purpose was to listen to the shots and get an on-the-scene feeling for their possible source and their magnitude.

The chief scientist in the ear-witness project is Dr. David Green. Dr. Green is a professor of psychophysics and chairman of the Department of Psychology and Social Relations at Harvard University.

He received a B.A. degree from the University of Chicago in 1952, and from the University of Michigan he received a B.A. degree in 1954, an M.A. degree in 1955, and a Ph. D. degree in 1958.

He has been a professor of psychology at the University of California and an associate professor of psychology at the University of Pennsylvania, and an assistant professor of psychology at the Massachusetts Institute of Technology.

Dr. Green is the author of numerous scientific publications, and he serves on the editorial boards of several scientific journals. He is a fellow of the American Psychological Association and the Acoustical Society of America.

Dr. Green is the chairman of the National Research Council Committee on Hearing, Bioacoustics and Biomechanics. He has received the Acoustial Society of America's Biennial Award and a Guggenheim fellowship. He was an overseas fellow at St. John's College in Cambridge, and in 1978 he was elected to the National Academy of Science.

At this time, Mr. Chairman, it would be——

Mr. FITHIAN. Would the gentleman suspend.

Just for clarification, Mr. Chairman, were we not going to ask any questions of Dr. Hartmann, or does that follow this?

Mr. BLAKEY. My understanding is that Dr. Hartmann will be called back to the stand at the conclusion of Dr. Green's testimony.

Mr. FITHIAN. Thank you.

Chairman STOKES. The committee calls Dr. Green.

Doctor, will you raise your right hand and be sworn.

Do you solemnly swear the testimony you give before this committee is the truth, the whole truth, and nothing but the truth, so help you God?

Dr. GREEN. I do.

Chairman STOKES. Thank you. You may be seated.

The Chair recognizes counsel for committee, Lee Matthews.

Mr. MATTHEWS. Thank you, Mr. Chairman.

TESTIMONY OF DAVID GREEN, PROFESSOR OF PSYCHOPHYSICS AND CHAIRMAN OF THE DEPARTMENT OF PSYCHOLOGY AND SOCIAL RELATIONS, HARVARD UNIVERSITY

Mr. MATTHEWS. Dr. Green, would you begin by tracing the history and development of psychoacoustics in America?

Dr. GREEN. Well, the field of psychoacoustics I think, at least modern psychoacoustics, dates from the development of electronic equipment.

Certainly two key events were the laboratories at the Bell Telephone Laboratories, under Dr. Fletcher, as well as the laboratory of psychophysics at Harvard University, under Dr. Stevens.

At those laboratories, various experiments were performed in connection with how people hear, and concerned with devices related to how they hear, such as earphones, earplugs to protect their hearing, and the like.

The psychoacoustics lab during the Second World War was specifically charged with the problem of communications in airplanes, and so they did a great deal of work on radio sets; microphones, headsets, and so forth.

Mr. MATTHEWS. Would you give us some examples of how psychoacoustic analyses are conducted, and some of the conclusions that can be drawn from the experiments?

Dr. GREEN. I think probably most relevant to this committee would be a brief discussion how we, how people, localize sound in space.

For that purpose, a typical experiment would involve having two or more sources of sound and asking the subjects to differentiate or distinguish among the sources. So, we might sound one or another source and ask the subject to tell us which source was actually sounded.

You will note that in these tests there is an element of subjectivity; that is, the observer or witness is obviously being asked a question about what he experiences.

But I hope you also note that you can score these tests objectively; that is, you can actually find out whether he can distinguish between two sources located a few inches apart at a certain distance.

By varying the physical parameters of the situation—that is, the distance, between the sources; or their distance from the observer—by varying the composition of the sources—that is, the sounds they make or their loudness—you can begin to understand how the subject localizes sound in space and study the variables that effect this sort of behavior in an objective fashion; that is, in a fashion that any other experimenter could presumably repeat.

Mr. MATTHEWS. Now, is that primarily a subjective test or are there objective aspects of it?

Dr. GREEN. Well, it is subjective in the sense that you use human observers and they make judgments. But your scoring of their responses is fundamentally objective; that is, we can all agree on whether the subjects get the correct or incorrect answer. So in that sense it is objective.

Mr. MATTHEWS. Dr. Green, I want to call your attention to JFK exhibit No. F-364 that has previously been entered into the record in this case.

First, are you familiar with that exhibit?

Dr. GREEN. Yes, I am. I remember this morning's presentation.

Mr. MATTHEWS. Can you give the committee an explanation of how human beings recognize the sound of rifle fire?

Dr. GREEN. May I approach the exhibit, please?

Mr. MATTHEWS. Certainly. May I also refer to JFK exhibit No. F-357 previously entered and what has been identified as JFK F-363.

Dr. GREEN. I will try not to be too repetitious, but I would like to review just briefly several aspects of the situation that are pertinent to how subjects localize weapon fire.

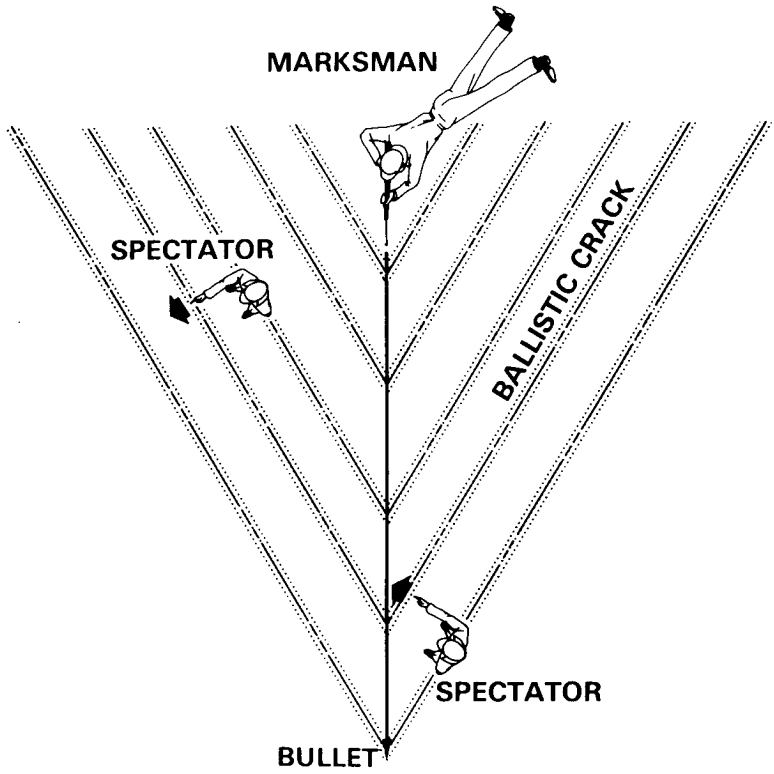
As Dr. Barger pointed out this morning, this is the pressure wave, that is, this is pressure on this axis and this is time. When a weapon is fired, if it is a supersonic missile, then a shock wave is produced. That is this little N shaped blip. And then finally the muzzle blast comes in later which is the large explosive sound caused by gases coming out of the muzzle.

But the shock wave is of interest when you study the localization of sound because it causes confusion as to the locus of the sound in space. That is best illustrated on this exhibit where we have the rifle here at one instant in time. It has been fired and there is a bullet along this projectory, that has reached this point in space, as a result there is a shock wave or N wave that follows the bullet. There is also a blast wave traveling at the speed of sound away from the muzzle.

Now you should be familiar with roughly this sort of situation because if you will think of a boat traveling in still water, the surface wave is in fact or the bow wave of the boat is in fact like the N wave. The difference here is that this is a bullet going through air so this figure should be rotated completely around and there is really a cone that follows the bullet that creates the N wave. Meanwhile, the shot, the blast is expanding in a circle about the muzzle, at least in free space.

Now if you take an observer in this position on the path of the shock wave, the shock wave which is a cone in free space passes over the observer in this direction. Therefore, the sound that sweeps over him is essentially a plane wave. For example, if he is standing in this direction, it strikes both ears at the same time.

[The information follows:]



JFK EXHIBIT F-363

Dr. GREEN. Therefore, the observer in this situation will tend to point at the path of the bullet and perpendicular to the N wave. This is illustrated in this figure where the marksman is here and the bullet being fired in this direction and these outer lines represent the N wave at successive instances in time and the spectators pointing perpendicular to the N wave and at the path of the bullet.

This is actually a fairly accurate representation of an experiment carried out by Dr. Garinther at the Aberdeen Proving Ground, and in his experiment, he had a group of subjects, about 30 or 40 subjects seated in an open field. The marksman was concealed in a truck and hence the blast wave was silenced effectively. He shot through a small opening in the truck and down a path. The observers sat in a row and they actually pointed exactly as you would expect from this diagram.

This diagram also points out that while 75 percent of the observers point in a perpendicular to the N wave, at the path of the bullet, 25 percent of the observers point in exactly the opposite direction. This is called front-back confusion because the sound waves hit both ears simultaneously it is awfully confusing and you can't tell whether the source is immediately ahead or immediately in back of you.

Mr. MATTHEWS. The Garinther test, and JFK exhibit No. F-363 are the exhibits you were referring to?

Dr. GREEN. I will have to look on the back to tell, but I think it was. Yes, it is F-363.

Mr. MATTHEWS. The other exhibit that you referred to earlier is JFK exhibit No. F-357?

Dr. GREEN. That is right.

Mr. MATTHEWS. That exhibit contained the drawing of the shock wave and the muzzle blast wave?

Dr. GREEN. That is correct.

Mr. MATTHEWS. Now what difference does it make in the position of the observer in determining either the origin of the shot or path of the bullet?

Dr. GREEN. Well, if the observer hears the blast wave as if he were located at a position here, this plane wave has an origin back here at the rifle. So he actually points at the source of the disturbance. If the observer does not hear the blast wave, if he localizes on the basis of the N wave, he actually points at the path of the bullet, not the origin, of the bullet, in a way dictated by this geometry, that is perpendicular to the cone of the end wave and toward the path of the bullet.

So, for example, if the marksman were up here in that corner [points at one corner of room] firing into that corner [the opposite corner] and we could not hear the blast of the rifle, that is, we simply heard the N wave, we would localize the source of the sound up in the ceiling.

Mr. MATTHEWS. You mentioned in regard to JFK No. F-363 that Garinther conducted an experiment in which the blast wave was concealed?

Dr. GREEN. Yes, the marksman was concealed in the truck. The blast wave was suppressed and only the N wave was evident.

Mr. MATTHEWS. Were any of the observers able to accurately pinpoint the point of origin for the gunman?

Dr. GREEN. No, they all either pointed along the path of the bullet, 75 percent of them, and 25 percent pointed in the opposite direction.

Let me make one other point clear if I can while I am at that diagram. That is, the relative contribution of the blast and N wave depends on where the observer is standing in space. If he is way down here along the path of the bullet, the blast wave is getting weaker and weaker but he is fairly close to the path of the bullet, therefore is little diminution in the N wave as it goes by. Because he is way down here in space there is a great difference in time between when the N wave passes and the blast passes so it is very possible in certain locations especially if you are located well down the path of the bullet, you hear the N wave and a long time later it is followed by the blast wave.

Mr. MATTHEWS. Is there any position that an observer can stand relative to the origin of the shot, where there is a greater possibility of being able to locate the shooter?

Dr. GREEN. Yes, if he is located here at the side, then the shock and the end wave and the blast wave arrive at the same time and he would point at the origin of the source, that is, the rifle in this case.

Mr. MATTHEWS. Can you give us some indication of the distance that the person would be from the origin of the shot, where they would hear the end wave first and then subsequently the blast?

Dr. GREEN. Well down the line of the bullet. If they are well down the line of the bullet, the N wave will sweep over them first and the blast will come in later and in that case it would be very probable that they point at the N wave and ignore the blast as an echo. If they are off to the side, they will undoubtedly point at the source of the muzzle.

Mr. MATTHEWS. Can you give us an opinion, based upon distance in feet, that the observer would have to be standing from the origin of the shot, to recognize the N wave and then subsequently recognize the blast?

Dr. GREEN. I can't give you exact data on that subject because I don't think it has been studied in that detail, but let me review the considerations that apply.

The further he is from the rifle and the closer to the bullet path the more the delay between the blast and the N wave.

So, for example, if he were 300 feet, down here, the blast would lag the N wave, and if he were very near the path of the bullet, the blast would lag the N wave by half that distance 150 feet or about 150 milliseconds.

In that case, it is very probable that he would hear the blast very distinctly as a second wave.

Mr. MATTHEWS. Mr. Chairman, at this time I move for the admission of JFK F-363.

Chairman STOKES. Without objection it may be entered into the record.

Mr. MATTHEWS. Dr. Green, are there distinct sounds between the sensations of the N wave that you have described as the shock wave and that of the muzzle blast?

Dr. GREEN. Definitely, and you can see some indicaton of how these might sound by just looking at the exhibit on the far right.

The shock wave is very brief and the muzzle blast is longer in duration. Therefore, there is a great difference in pitch. The N wave sounds much higher in pitch than the blast wave. We have a tape recording of those two waves. It is a recording of a Mannlicher-Carcano firing in which we have excised from the tape examples of the shock wave and the muzzle blast.

If I may, could I play those to the committee and let them hear the difference between the two sounds?

Mr. MATTHEWS. Yes, Mr. Chairman, at this time I would move for the admission of JFK F-351 and JFK F-352.

Chairman STOKES. Without objection they may be entered into the record at this point.

[JFK exhibits F-351 and F-352 are tape recordings retained in committee files.]

Mr. MATTHEWS. Dr. Green, would you explain to the members of the committee exactly what they can expect to hear from each of those exhibits?

Dr. GREEN. There are three blast waves, that is the larger wave in the far right of the exhibit F-364. They are played three times. They are followed after a brief pause by three examples of an N wave played at the same peak overpressure.

Now, the intensities that you will hear in this room are nowhere near the intensities that you would experience if you listened to actual weapons. So you should recall that they will be much lower in intensity than anything resembling rifle or pistol fire, but nevertheless there are recordings of these two wave forms, and if we can have them at this time, you will hear three blast waves followed by three shock waves.

[Tape recordings played for the committee.]

Mr. MATTHEWS. Dr. Green, I believe you were present when the tape recording was played of four shots that were fired in Dealey Plaza?

Dr. GREEN. I beg your pardon?

Mr. MATTHEWS. You were present in the room at the time of Dr. Barger's testimony when the recording was played of shots fired in the Dealey Plaza experiment?

Dr. GREEN. Yes; I was.

Mr. MATTHEWS. How were those shots different from the shots that you played today on exhibit JFK F-351 and JFK F-352?

Dr. GREEN. The most noticeable difference is that nobody jumped in the room, and if rifle fire occurred in this room, I am sure everybody would have left their chair, at least slightly. They are extremely quiet compared to the shots that occurred in the plaza. But, I played them merely to illustrate there is a quality of difference in the sound produced by these two types of waves.

Mr. MATTHEWS. Were you able to distinguish and separate the sounds that you played on those recordings without the use of special equipment?

Dr. GREEN. I am unclear as to the question, I am sorry.

Mr. MATTHEWS. How were you able to obtain simply the blast itself on the recording?

Dr. GREEN. They were excised from actual rifle shots. We stood in a position where there would be a sufficient time difference between them and then cut them out of the tape and pasted them in the sequence that you heard them. So they are artifically prepared so that it would be clear that N wave and blasts waves could be distinguished.

Mr. MATTHEWS. Dr. Green, I want to call your attention to JFK F-361 and ask you whether or not you recognize this exhibit?

Dr. GREEN. It is an aerial photograph of Dealey Plaza.

Mr. MATTHEWS. On August 20 of this year you had occasion to be present at the time of the acoustic analysis testing in Dealey Plaza?

Dr. GREEN. Yes; I and two observers went to Dallas and observed during the sequence of shots that Dr. Barger has already described. The two observers were Prof. Frederick Wightman, an associate professor of audiology in the Department of Communicative Disorders at Northwestern University. He has had considerable experience in the field of sound localization and has contributed many papers and literature on that topic.

The other observer was Prof. Dennis McFadden of the Psychology Department of the University of Texas at Austin. He also has a long history of research in the field of sound localization and has contributed many papers on that topic.

Mr. MATTHEWS. Now, the purpose of the three of you all being there primarily was to determine what the witnesses heard who had been spectators of the Presidential motorcade on November 22, 1973; is that correct?

Dr. GREEN. That is correct. We observed in several different locations within the Plaza and compared the apparent locus of the sound and blasts that we heard and attempted to correlate them with reports gleaned from the witnesses, after the assassination.

Mr. MATTHEWS. Dr. Green, I want to call your attention to JFK Exhibit F-344 and F-337, both of which have previously been entered into evidence and ask you to approach the podium and indicate the relative position where you and the observers stood during the experiment and the reasons why you selected that particular position.

Dr. GREEN. You will recall there were three sequences of shots that were going to be fired and for the first sequence we were situated about in this position on the grassy knoll, about halfway down the slope.

We decided for the first sequence that the observers would stay together, that is, I had them located about three feet from one another and as they filled out their responses to each of the test shots, I would check their responses to see to what degree they were consistent.

As a result of this first sequence it was apparent that they were very consistent and that we could gain more information by separating the observers. So for later test shots we observed some of the test shots together right under the Texas Book Depository in the second sequence. For the third sequence of shots Professor Wightman and I were situated down here and Professor McFadden was situated on the railroad overpass in about this position in this exhibit while the third sequence was fired.

Mr. MATTHEWS. During the course of the first sequence what degree of accuracy was there between the two assistants?

Dr. GREEN. There were 12 shots shown in the sequence, but because there were 5 test shots that preceded the sequences that were run off here, there was a total of 17 shots fired and the observers, Wightman and McFadden, they rated all of the 17 test shots, they were in agreement on 94 percent of their responses. Their locations were the same, their reports of reverberations were identical, and their reports of the loudness were virtually the same.

Mr. MATTHEWS. Did you know at the time the shots were being fired, what was the position of the rifle?

Dr. GREEN. I knew the key but even I was somewhat at a loss to know where we were within the sequence. Because there were test shots preceding the sequence and occasionally some of the shots would be refired because the recording equipment was malfunctioning or something and I was not in communication with anybody concerning the number of the sequence during the shots so they were essentially unaware of what shot was going to be fired next.

Mr. MATTHEWS. Would you explain to the committee exactly what they heard during the process of those tests.

Dr. GREEN. Well, they were seated here in the first sequence, for example, and the first shot would be out here on target one. And immediately thereafter they would write down where they thought

the shot occurred, comment about any other apparent echoes or confusions that might have occurred, rate the loudness of the sound, and any other comments that they thought pertinent.

As I say, they agreed in that first sequence virtually 100 percent of the time. There was one shot that McFadden heard, it was the second shot No. 11 at target 3, and he localized that over at this old courthouse. If you draw the path of the bullet and point at the N wave, that would point at the old courthouse. That was the only response that McFadden differed from Dr. Wightman and the only one where he was inaccurate.

Mr. MATTHEWS. When each of your assistants stood in the assigned places, did it make any difference which direction they were facing at the time of the shots?

Dr. GREEN. Not so much in this position, but when you are situated immediately under the Texas School Book Depository, which was our general location for the second sequence of shots, two things are rather confusing.

First of all, the N wave comes right over your head so you tend to localize the source directly over your head or on occasion you directly localize the source in whatever direction you were facing. You could, for example, move your head into different directions.

I once looked down Elm Street in this direction fairly well convinced that the sound came from this direction, and the other observers did likewise, pointed their heads in different directions and said that that influenced their judgments.

Also when you are in this location the sound sweeps down the building and the apparent source of the sound is rather large, probably because it scattered off the regular surface of the building. That was caused by the blast wave.

Mr. MATTHEWS. At any time during the testing did your assistants confuse the sounds of the N wave and blast with any sounds of echoes or reverberations?

Dr. GREEN. They certainly made some inaccurate responses. I would say in the order of 10 percent, and most of those could be accounted for on the basis of the confusion of the blasts and the shock wave.

On other occasions, for example, in this location where we are a good distance from the sixth floor window of the Texas Book Depository, and that was the source of the rifle blasts, it is fairly easy here to hear both shock and blast waves. They occurred with sufficient delay from one another that Wightman, for example, would write down that the N wave appeared somewhere in the air over the knoll and the blast would come from the Texas School Book Depository.

Mr. MATTHEWS. Now what is it that you had your assistants identify, both the N wave and the muzzle blast or just simply the rifle shot?

Dr. GREEN. They tried to report what they heard and also tried to make a guess as to what was the location of the actual weapon, but in this case it was just very easy for Wightman to distinguish the two so he kept writing down on his score sheet that the click, the N wave, appeared to have a locus somewhere over the knoll.

Standing here the N wave was coming down and hitting targets down here, or in the case of the Main Street shots, way down here,

so he would localize it up in space there. Then he would comment that in addition when the blast came in, it came from the Texas School Book Depository.

Mr. MATTHEWS. They were identifying each of the sounds they heard?

Dr. GREEN. Yes.

Mr. MATTHEWS. It may have been two sounds—the muzzle blast——

Dr. GREEN. They also commented about echoes, et cetera. For example, in this position from the knoll, we were sufficiently up the knoll, that we heard a very strong echo off the post office annex that came in about a second later. In this position you hear a very strong echo off the triple underpass and McFadden in this position heard the strong echo off this array of buildings along Houston Street.

Mr. MATTHEWS. Which of the assistants did you have standing in the area south of the TSBD Building, the grassy area right across from Elm Street?

Dr. GREEN. I stood there with Wightman.

Mr. MATTHEWS. And the area immediately north of that known as the grassy knoll?

Dr. GREEN. All three of us stood there for the first sequence of shots.

Mr. MATTHEWS. What did they observe at that time as to the sequence of the shots?

Dr. GREEN. With the exception of McFadden who we think confused the N wave and pointed to the courthouse, they all scored 100 percent, that is, they could correctly locate the source of the sound. Any rifle shot from the Knoll was quite evident. It was a very, very loud sound. You almost jumped when the rifle was fired from such a close distance. We were within probably 30 to 40 feet of the muzzle blast. The pistol was quieter and it was subsonic so it did not produce an N wave. It was extremely easy to localize because it was such a relatively small sound compared with the massive blasts of the rifle.

Mr. MATTHEWS. Mr. Chairman, at this time I move for the admission of JFK F-361.

Chairman STOKES. Without objection it may be entered into the record at this point.

[The information follows:]

JFK EXHIBIT F-361

Mr. MATTHEWS. Dr. Green, what were some of your first research and analysis in this case?

Dr. GREEN. The first work I did was, I looked at a statistical survey prepared by Josiah Thompson from his book, Six Seconds in Dallas—I think that was the name of it—in which he compiled some of the witness' testimony as to the locus of the shots. I was slightly confused concerning that analysis and somewhat doubtful of it because of what I have tried to review concerning the apparent location of weapon firing. He claimed a low percentage of his respondents' recording anything other than the Texas Book or the knoll as the potential location of the rifle.

Sixty-six percent in his analysis reported they didn't know, and only 3 percent reported that any other location other than the Texas Book or the knoll.

Mr. MATTHEWS. Mr. Chairman, at this time I would move for the admission of JFK F-360, the chart that was composed by the committee staff. I would add, Mr. Chairman, that it was composed based upon the number of witnesses at Dealey Plaza whose location could be pinpointed and who could give pertinent information relating to the number of shots and the spacing of those shots and the origin of those shots.

This information was taken from the official files and reports of law enforcement agencies and from testimony before the Warren Commission.

Chairman STOKES. Without objection it may be entered into the record at this point.

[The information follows:]

TABLE III

Number of Shots Reported

	2	2 or 3	3	4	DON'T KNOW	TOTAL
TSBD	3 (4.6)	2 (1.9)	38 (35.5)	2 (1.6)	1 (2.4)	46
KNOLL	5 (2.0)	2 (0.8)	11 (15.4)	0 (0.7)	2 (1.1)	20
OTHER	2 (2.9)	1 (1.2)	22 (22.4)	3 (1.0)	1 (1.5)	29
DON'T KNOW	7 (7.5)	2 (3.1)	61 (58.6)	1 (2.7)	5 (4.0)	76
TOTAL	17	7	132	6	9	171*

The first entry is the obtained data. The number in parenthesis is the expected number of such judgements if the source and number of shots are independent judgements.

*7 other witnesses report 1, 4-5, 5, 6 or 8 shots.

JFK EXHIBIT F-360

Mr. MATTHEWS. Dr. Green, I direct your attention to JFK exhibit No. F-360. Are you familiar with that chart?

Dr. GREEN. Yes, that is a chart that I prepared based on the analysis that you provided. Along the columns of the matrix there are reports on the number of shots the witnesses heard.

For example, along the top some of the witnesses, 17, reported that there were 2 shots out of a total of 178. The vast majority, almost 77 percent, 132 out of 178, reported that there were 3 shots fired. Along the rest of the matrix are the lists of the place of the origin of the shots as reported by the spectators, that is, the Texas School Book Depository was pointed to by 46 out of 178 respondents. The knoll was pointed to by 20. The other response, that is, other than the knoll or the Texas Book, 29 spectators, and 76 subjects, about 44 percent, reported that they did not know the location of the shots.

Mr. MATTHEWS. Would you make a comparison of the data obtained in this research and the results of the information obtained

from your field tests, then can you make a determination of which of these witnesses would have been correct in localizing the shots?

Dr. GREEN. No; I don't think you can, for the reasons that I tried to outline earlier because a variety of determinants actually influence the judgment. In some cases the way the subject was facing, in other cases whether he heard the blast or the N wave and made his localization judgment based on the former or the latter.

What I have tried to do in the interior in that table in the actual entries in the table is to test the assumption that there is essentially independence between where the witnesses point as the origin of the shot and the number of shots that they report.

So what I have done in that table is essentially assume that the two judgments are completely independent and try to predict how many subjects would fall in each cell of that matrix on the basis of that assumption of independence.

So, for example, using that assumption in the upper lefthand corner there, you see that there were three subjects that in fact pointed at the Texas School Book Depository and reported they heard two shots point under the assumption of independence you would expect 4.6 to be the number, et cetera.

You can see by the close correspondence between the numbers in brackets and the bold numbers above them that you can essentially assume independence between the two types of judgments. If you entertain the hypothesis that only people who could hear that the shot came from the knoll might be expected to hear the fourth shot, the three others coming from the Book Depository, you might expect that assumption of independence would be violated, but as you can see, there is no evidence in that table to indicate that that is the case.

Mr. MATTHEWS. Now after completing the research analysis and the field tests in this case, have you had an opportunity to confer with your associates in this matter?

Dr. GREEN. Well, after the tests, we discussed for 3 or 4 hours what we had heard and talked about what we had heard with respect to the reports that we had seen from the witnesses.

I also drafted a preliminary report which they have seen and essentially concur with. I think we are in general agreement about the results of this test.

Mr. MATTHEWS. Based upon that research, will you give your opinion to the committee today as to final conclusions?

Dr. GREEN. I think the first conclusion is that we were very surprised at the loudness of the sounds that we heard. We had read reports from the witnesses of firecracker-like sounds and the like. These gunshots were truly enormous in intensity, as you could see from some of the numbers that Dr. Barger reported this morning, the peak overpressures of these waves are very large.

I might add that throughout the first and second tests we attempted to simulate some of the noise in the Plaza by running a motorcycle. Actually, we had three motorcycles present and we ran the motorcycles to provide masking noise during the test, but it soon became apparent that the motorcycles were unnecessary. They did not mask any of the important sounds we observed. The rifle blasts clearly overcame them. They simply prevented us from

having conversation with each other so we dispensed with them in the latter sequence of tests.

We are simply unable to offer any explanation for why some of the observers reported these relatively small sounds when we know the intensities and loudness produced by the Mannlicher-Carcano.

Several witnesses were hunters and they reported rifle blasts, but there were several others who reported the sounds to be extremely small.

The second conclusion would be to comment again about the consistency of the observers. They were extremely consistent in their responses. In general they were fairly accurate, probably in the 90 percent range. This may be due to the fact that they are well practiced in this sort of task. It may also be due to the fact that they knew that the rifles were going to be fired, whereas the spectators were caught largely unaware, or it may be due to the emotional response of the subjects that occurred after the first or second shots were fired.

Unfortunately, I know of no research, no evidence that would indicate how that would affect their judgments so I simply cannot comment on those differences. But our subjects, and our witnesses, were remarkably consistent.

The third thing I would mention is that there are strong reverberations and echoes present in the plaza. For the most part, these did not cause confusion among our witnesses because they occurred sufficiently late in time so that they were clearly recognized as echoes, the echo off the post office annex building for example, arrived about nine-tenths of a second late. It was clearly heard as an echo off the post office annex building.

Probably a more potential source of confusion was the echo off the railroad underpass, especially when you are located immediately under the Texas School Book Depository, because the N wave coming over your head out of the Depository is very confusing so you are sort of startled and nothing makes much sense, especially if you think the sound is right up above your head.

So the first sound that arrives from any object on the ground comes from the railroad underpass. I think I also commented that from the railroad itself there are strong echoes off the buildings on Houston Street.

A fourth thing I would comment on, that I have touched on already any sort of a knoll shot, whether it be rifle or pistol—and these were both unsilenced weapons, but I am not sure that makes a great deal of difference—any sort of knoll shot when observed from at least several locations, particularly the knoll itself, immediately across from the knoll, and to some extent below the Texas Book Depository, is a very easy place to localize sound. That is a shot from the knoll is usually heard as a shot from the knoll.

There were few errors on that. In fact, I don't think there were any errors on that particular shot. So if there was a shot from the knoll, it is extremely easy to localize it at the knoll.

Finally, I would like to make one observation that I think is inconsistent with the argument that there were three shots from the Texas Book Depository and one from the knoll. That is, if there were any shots from the Texas School Book Depository and at least one from the knoll, one might expect, since these judgments are

not all that difficult, that many subjects would report two sources for the locus of the shots, that is, they would report both the Texas Book Depository and the knoll as places from which weapons were fired.

If you go over the statistical survey of the 178 observers who gave reports, there are exactly 4 that mentioned dual locations, that is, that say the locus of the shots came from two places. I find that a strikingly low number given the hypothesis that the weapons were actually fired from two places.

We found that it was comparatively easy to localize knoll shots, at least from the knoll, across from the knoll; and to some extent under the Texas School Depository, and there was little doubt in the vicinity of the Depository that a shot was fired from that building.

I think that concludes it.

Mr. MATTHEWS. Did it make any difference in localizing the origin of the shot where the target was?

Dr. GREEN. It changed the character of the sound somewhat because in various locations you would either hear N wave or not. So I would not say that it did not make any difference, but as to the localization response, it generally was not terribly important.

Mr. MATTHEWS. Mr. Chairman, I have no further questions.

Chairman STOKES. The first questioning of the witness is to be by Mr. Fithian. We have a vote on the floor. So I think we will recess for about 5 minutes and then we will resume questioning the witness.

[A brief recess was taken.]

Mr. FITHIAN [presiding]. The committee will come to order.

Mr. Matthews?

Mr. MATTHEWS. Dr. Green, you were present during the course of Dr. Barger's testimony, and if you recall, he mentioned that some of the shots fired from the TSBD building were from a position within 2 or 3 feet inside the window.

What effect would that have had upon the witness' opinion of the origin of the shots?

Dr. GREEN. The intention of that manipulation was to suppress to some extent the blast wave and to make the N wave more noticeable compared to the blast wave. I would say it was marginally successful, but perhaps because of the sophistication of my subjects they all reported they generally heard the blast with some minor exceptions.

When Dr. McFadden was on the railroad overpass the farthest distance from the Texas Book Depository, and the target was No. 4 which is almost again the railroad overpass down there on the bottom, he was often confused and heard a source directly up Main Street, he said.

So I am not sure what he heard, whether he heard an N wave. The cone of the N wave didn't sweep over him but some part of the N wave may have still reached him, but in any case he made that observation.

But for the most part, it would be difficult to detect from the data itself whether the manipulation of moving the rifle muzzle back had any effect. It was our impression that it made the N wave

more evident, but whether we knew that should happen and therefore heard it or whether it actually happened I am not sure.

Mr. MATTHEWS. Thank you, Dr. Green. I have no further questions, Mr. Chairman.

Mr. FITHIAN. Dr. Green, with regard to the original ear witnesses, I had to step out for two votes and perhaps you covered this, but I am curious to know whether or not you can tell us anything about the probability of accuracy of those individuals.

Dr. GREEN. I did comment on that while you were gone. The short answer is: I can't contribute very much. All of the experiments that contribute to our knowledge about localization are done in these rather routine and repetitive tests where you essentially put two sound objects at some distance, play one or the other, and ask the subject to tell you which one occurred.

So in these cases the subject is always well aware that there are a limited number of sound sources and he knows what discrimination he is supposed to make and he makes it over and over repetitively. Whereas, in the situation we are talking about here, of course, everybody was surprised by the first shot. I really can't say what effect that would have. There is no available literature on that sort of situation and it would be largely speculation on my part.

There are some experiments where the range of signal alternatives is not known to the subject. In this case these are detection experiments, trying to detect a weak sound in noise as a matter of fact, and the fact that the subject doesn't know which sound to expect does not make as much difference as you might expect. The difference is about a decibel.

Mr. FITHIAN. There has been a great deal of testimony by individuals and not a little literature indicating that a fair body of people who identified the sound indicated that the sounds came from two different directions, a very significant number as I recall, 40-some, testified that they heard shots which came from—and they pointed or otherwise indicated what came to the Texas School Depository window, and something in excess of one-half dozen identified the grassy knoll and in fact some policemen apparently took off toward the grassy knoll and other eyewitnesses said they saw a puff of smoke from the grassy knoll, et cetera.

What I am trying to elicit from you is any help your expertise can give us in sorting out the validity of the ear and eyewitness testimony that we have in the Warren Commission report.

Dr. GREEN. Let me go back to your first statement because I think we seem to be in disagreement about facts if I heard you correctly.

There were very few subjects who reported two locations were the source of the sound. I know of only 4 in the list of 178. There were a large number of subjects who reported they didn't know or were confused by the echo's reverberations, et cetera.

I have tried to point out that the rifle blast particularly, because of the N wave, creates a very confusing acoustic stimulus and you are liable to point at the N wave. Whether that makes any sense or not is another matter.

You can point at the sky for example, if you were down on the street level and the path of the bullet goes over your head and I

would think you would then report you don't know the source of the sound because it is very confusing for the sound to be up in the sky. If you take a single subject out of the plaza and ask me on the basis of his report would he be likely to be more accurate than any other subject, I simply could not say there is any more likelihood that one subject would be more accurate than another.

Mr. FITHIAN. If you will suspend for just one moment, Dr. Green, I would like to have entered into the record JFK F-362 and have it displayed on the easel for a couple of questions of the witness.

[The information follows:]

REPORTED ORIGIN OF SOUND

WHERE THEY STOOD	TSBD	KNOLL	OTHER	DON'T KNOW	TOTAL
IN THE TRIANGLE	5	1	4	2	12
ON THE KNOLL	3	2	1	1	7
TSBD	16	1	10	3	30
R. R. OVERPASS	4	0	6	1	11
ELM STREET	13	3	11	3	30
TOTAL	41	7	32	10	90

JFK EXHIBIT F-362

Mr. FITHIAN. Now, Counsel Cornwell, in the preliminary analysis made of this chart there seems to be some confusion about the numbers. Could you first of all clarify, since the total of 90 in the lower righthand corner does not equal the total number of ear witness accounts we have, how exactly this chart was constructed?

Mr. CORNWELL. The difference between the two charts, first, is that the chart that Dr. Green has previously made reference to includes persons scattered all over the plaza. The second chart has a more limited function. It was designed to facilitate direct focus upon the reported origin of shots from those persons who stood in the same areas of the plaza that Dr. Green and his listeners stood.

Therefore, the figure "90" in the chart which was just put up is a smaller number than the total number of observations, 171, reported in the earlier chart. The 90 figure is a very restrictive one. It is taking the basic four areas that Dr. Green's listeners stood; namely, in the grassy triangle, on the knoll, in front of the TSBD, in the railroad overpass, and on Elm Street, and simply selecting those persons who we knew were standing in those areas and

reporting where they said, for each of the areas, the shots originated.

Mr. FITHIAN. Now, Dr. Green, whether we use your figures, that is, the figures in the chart already introduced, or the one just introduced, we get several people, 7 in the latter and I believe 20 in the former, who identified the grassy knoll as the source. Is that correct?

Dr. GREEN. That is correct.

Mr. FITHIAN. From all you know about where the shots were fired and applying the science of your training, could that many people, wherever they were located, identify the shots as deriving from the grassy knoll in the absence of a shot from that area?

Dr. GREEN. In my opinion, easily. Certainly the long shots, especially if you take those subjects that are further up Elm toward the Book, could have very easily confused the N wave. The N wave is in front of them. They make a front-back confusion and they will point to the knoll.

I counted a total of something like 10 subjects that point toward the Knoll that stood in that area. I am a little more generous in my definition of knoll than this chart that has been introduced. But there are about 10 people. There are a few people scattered over the rest of the plaza that also report the knoll. There are two or three in the Book, several down in the triangle, one on the railroad tracks, a couple by the courthouse, et cetera. I don't find it surprising that some of those people; that is, a relatively small percentage, could point at the knoll despite the fact that nothing was fired from the knoll.

What I do find more surprising is what I stated as my final conclusion, that if there was somebody firing from the knoll, and anybody firing anyplace else, why more people didn't hear both shots. As I said, only 4 out of the total of 178 heard two shots as the locus.

Mr. FITHIAN. Thank you.

Does counsel have any further questions?

Mr. MATTHEWS. I have none, Mr. Chairman.

Mr. FITHIAN. With the possibility that those who dashed out to vote on veteran's preference might want to recall you, I think we will excuse you now.

Under the rules of the committee, you are entitled to 5 additional minutes to clarify, amplify, and in any way modify your testimony here today.

Dr. GREEN. I have had plenty of time. Thank you very much.

Mr. FITHIAN. Thank you.

Dr. Green, just before you move away, I am not sure whether Congressman Dodd has any questions or not.

Mr. DODD. I don't immediately here, but I know both the chairman and Judge Preyer are coming right in.

Mr. FITHIAN. Why don't you just remain seated there and let's bring Dr. Hartmann up.

I would like to ask the staff to put up the appropriate jiggle analysis charts that we used this morning. I think they are unnumbered.

Mr. CORNWELL. I think they are No. 177.

Mr. DODD. Mr. Chairman, before you move on, maybe I could address a question to our last witness, if I could.

Dr. Green, as I understand it, you earlier testified that with respect to any one subject, you could not say whether or not he or she would be more or less likely accurate; is that correct?

Dr. GREEN. That is correct. I think I stated if you took a single subject out of the plaza and asked me if he or she were more or less likely to report the correct locus of the shot, I would not be able to say.

Mr. DODD. Are you familiar with the testimony of Governor and Mrs. Connally when they testified before this committee several days ago?

Dr. GREEN. I have read a newspaper report of it.

Mr. DODD. Just to refresh your memory, they indicated they felt quite clearly that the shots came from their right rear. What I am asking you is: Based on the statement that I just read as what I understood to be a paraphrase of your feelings, whether or not your inability to make a judgment on individual accuracy precludes you from aiding this committee in making a judgment on the accuracy of both the Governor's and his wife's statements as to the number of shots in addition to the direction.

Dr. GREEN. I am glad you brought that up because I looked at my testimony and see I didn't say much about the number of shots compared with my remarks about their locus and that is because I know of practically no literature on the topic. Experiments on subjects, guessing the number of loud sounds are, to my knowledge, lacking. So I don't really know what to say about the accuracy of those numbers. I have no way of giving you even a rough guess as to the accuracy.

I have heard informal reports that sometimes they are very inaccurate. My initial impression, looking at those numbers, was that the high numbers were obviously confusion with echoes; that is, there was one subject who reported eight shots and I presume he simply confused some of the echoes off some of the buildings.

But I could not really tell you how accurate the judgment of the numbers is. I know of no literature on this.

Mr. DODD. And you are stating for us as well that to the best of your knowledge there is no body of knowledge or information that we could seek out that would assist us in making that kind of an evaluation dealing with numbers now?

Dr. GREEN. Not to my knowledge.

Mr. DODD. Fine. Thank you very much, Mr. Chairman.

Chairman STOKES. Does counsel have anything further?

Mr. MATTHEWS. No, Mr. Chairman.

Chairman STOKES. Dr. Green, at the conclusion of a witness' testimony before our committee we extend him 5 minutes in which he may in any way explain or amplify or expand on his testimony in any way. I would like to extend 5 minutes to you at this time for that purpose.

Mr. DODD. If I may, Mr. Chairman, before you get that chance to refuse that offer, I asked you about direction and numbers. You responded in numbers, and I also wanted to ask that same question with regard to the Governor and Mrs. Connally's statement about direction of shots.

Dr. GREEN. The thing that makes my testimony uncertain is that the subjects that I took to the plaza were extremely accurate. They did not find these discriminations difficult.

The question at issue is my observers were expecting the shots, they knew they were coming. They didn't know the order but they knew they were coming from two locations. They were trained observers. If you have a subject that is unprepared for the shots, that is quite a different issue. I don't know how to extrapolate for that situation. I have commented that there is no available data on that sort of situation. There are certain locations that are best for observing certain shots and in the general region of the book depository, right on the street beneath it, in our opinion it was extremely easy to tell it came from the book. There was a massive sound to the right and rear that sort of crawled down the building, presumably due to scatter on the regular surface of the building and it was quite evident.

So I am not at all surprised at Governor and Mrs. Connally's report, but I can also look at the charts and there were other people standing near there, and some are pointing at the knoll when that event occurred.

So I can't tell you what circumstances led to that judgment other than to suggest that this is a complicated stimulus, that it depends in that location somewhat on where your head is pointed, for example. Other factors could also enter the judgment.

Mr. DODD. Fine.

Thank you.

Chairman STOKES. Dr. Green, you have 5 minutes.

Dr. GREEN. I have already refused your kind offer once and I will do so again.

Chairman STOKES. All right.

Well, thank you very much for appearing here and giving us the benefit of your testimony. You are excused.

The Chair now recognizes Mr. Fithian for further examination of Dr. Hartmann.

Mr. FITHIAN. Dr. Hartmann, I really don't have very many questions and I don't think it will take long.

Are the jiggle analysis techniques used by yourself and your associates for your presentation here today common interpretation techniques? In other words, what I am asking is: Have they been used to help interpret photos and films other than those from Dealey Plaza?

Dr. HARTMANN. I think the correct answer is no. In fact, I would like to emphasize that unlike much of the scientific data that you are getting such as on the acoustic work or the neutron activation analysis, this kind of technique does not have some scientific tradition of routine measurements, you do the measurements this way, this way, this way, and you get such and such an answer.

Here we were much more in a situation of making a common sense hypothesis at the beginning, meaning based on our common experience that a person is likely to react and the best information which I mentioned in my testimony indicates that people do react to that sort of thing and we tried to measure the film to see if there was a reaction, looked at each step as we went along and got the results I showed you.

Mr. FITHIAN. To the best of your knowledge did the Warren Commission employ this technique?

Dr. HARTMANN. I believe they did not. I think that the frame 210 that they identified was identified solely on criteria of some FBI agents estimating when a wound occurred and also that they constrained their shot times by this tree which grew in front of the window. They tended not to want to call for a shot when the President was behind this tree.

Mr. FITHIAN. Let's take the Zapruder film and give me the best estimate of your analysis. If any of the shots that were fired, whether they were three or four or two, if any of those shots were closer to Zapruder than the others, would you expect the blur or the jiggle or whatever the three of you were analyzing according to your own technique to be more pronounced than the more distant shots?

Dr. HARTMANN. I am not sure I can give you a firm answer on the basis of any psychological theory about how the man would have reacted except to indicate one of my own observations.

I think I was the only one in the group who stood on Zapruder's pedestal. That is not far from where the others were in the sequence of shots as was just indicated. But I stood on Zapruder's pedestal during that whole first sequence and the shots from the depository, this is my framework, I am looking out at the street. I had the sensation of a very large sound filling the street area up the street toward depository but the shots from the knoll were extremely loud in this ear and left my right ear ringing and my left ear not ringing.

So I had a very strong sensation from that shot, so I would have expected the witness to be more definite that there was something to the right if there had been a shot fired there.

Mr. FITHIAN. Assuming that the intensity of the unexpected noise has something to do with the amount of reaction of the subject, which I take it is what you just said, is there anything that we can learn, looking at your chart, as to the possibility that any of the shots came from the grassy knoll?

Dr. HARTMANN. I believe not because there are clearly reactions or jiggles. I should not even say reactions because we don't know that every jiggle is a reaction to something. Some of the jiggles may be ordinary panning areas. There are clearly jiggles of different magnitude on there. What we don't know is whether there are several kinds of stimuli initiating jiggles.

By that I am trying to say that there is the classic involuntary startle reaction which is going to produce jiggles. There may be an emotional reaction following that caused by what the man sees through his viewfinder. There may be an emotional reaction caused by what he perceives is going on. The instant where he perceives there is actual gunfire going on here in this plaza in front of me may change his bodily reaction. I think it is very hard to say.

Mr. FITHIAN. Is that a possible explanation of the fact that clear over to the righthand corner of your own chart the disturbances are not only greater amplitude up and down, if you want to use that term, but more pronounced from there on out to the end of the chart?

Dr. HARTMANN. Yes, I think we definitely have that. I should have said that earlier this morning. From 310 onward, which as you say is the righthand corner of those last three charts, Mr. Zapruder has recognized what happened and that is based on his own testimony, as I understand it. He said that he saw the wound, he saw the President's head explode and he reacted very violently to that.

If I interpreted his testimony accurately, he began crying out shortly after that. As I reread the testimony, I could not confirm he was crying out or speaking as he ran the camera, although he says he cried out something like "They killed him" at the end of the sequence. He said he reacted very strongly. I am sure that that is what all that jiggle is at the end.

Mr. FITHIAN. So from your scientific analysis that could either have been started, that first major one could have been started by a shot closer at hand and therefore louder or by what he perceived through the lens. Is that what you are saying?

Dr. HARTMANN. It could have been. One can get even into the problem of whether there may be other gunfire stimulae buried in all that jiggle at the end. I don't think we can tell, but something clearly initiated that last sequence at 310.

Mr. FITHIAN. Just two small points: Did you view in any of the films that you viewed any motorcycles in the parade?

Dr. HARTMANN. Are you referring to the question raised during Dr. Barger's testimony whether a motorcycle might have caught up to the car?

Mr. FITHIAN. No. I was asking whether you viewed any motorcycles at all.

Dr. HARTMANN. Yes; sir, clearly at the beginning of the parade you see the motorcycles coming around the corner alongside the car and they stayed behind the car during much of the filmed sequence.

Mr. FITHIAN. During your analysis of the film did any of the motorcycles seem to be catching up or moving forward in their relative position in the parade?

Dr. HARTMANN. Not by any substantial amount, no.

Mr. FITHIAN. Mr. Chairman, I have no further questions of the witness.

Chairman STOKES. The time of the gentleman has expired.

The gentleman from North Carolina, Mr. Preyer.

Mr. PREYER. Thank you, Mr. Chairman.

I may have missed some of your testimony on the vote and I may be asking very simple questions, but from my understanding, does your jiggle analysis, when you match it with the Zapruder film, indicate a corresponding peak or reaction in your tape at the moments when President Kennedy was hit by two shots?

Dr. HARTMANN. Yes. Of course, the jiggle analysis comes only from the frames in the film. I think the conservative interpretation of that second chart from the left, which is the summary chart, is that it shows a violent set of jiggles initiated after what we know to be the fatal head shot and that we could characterize an earlier group of jiggles around frames 190 to 200. We know that the President apparently responded to this back wound about a second after that.

So I think we could infer that those two sets of jiggles are connected with the two shots that caused the wounds.

Mr. FITHIAN. If the gentleman would yield, I wonder if we might not introduce Mr. Chairman into evidence JFK exhibit 177A which I think would have applied to that last question and answer, but it has not been introduced yet today.

Chairman STOKES. Without objection it may be entered into the record at this point.

[The information follows:]

JFK EXHIBIT F-177A

Mr. PREYER. So that that exhibit indicates clearly the head shot.

Dr. HARTMANN. Yes. May I go over and——

Mr. PREYER. Surely.

Dr. HARTMANN. If I may, to answer your question, I think I can summarize what I perceive is the situation that we have right now.

Derived from the film is the fact that the photographer jiggled his camera at these times. And if we first look at it in a very broad-brush sense, we see there is a cluster of jiggling going on here and a cluster going on here. Those jiggles are fixed compared to what is happening in the motorcade and with respect to some time scale.

Now, floating free in space, or in time, on an unknown time scale, on a time scale which we don't know how it is connected to that diagram, is this spacing of shots, which the acoustics people have come up with.

The question is how do these fit. These shots could be anywhere along here. We can slide them along. But we cannot start this far back because then we don't have any shots up here to cause that first one. So we have to start sliding forward.

Frame 310 is right in here. So we know that there was a trigger pulled at that time. We could line up No. 3 or No. 4. No. 3 has perhaps been questioned a little bit more, and there is no medical evidence that the shot that hit the head came from the knoll. So perhaps No. 4 is the better lineup.

Mr. DODD. Would the gentleman yield at that point.

Mr. PREYER. All right.

Mr. DODD. You are stating with a pretty definitive assertion there that the trigger was pulled. What you are suggesting is not in fact that a trigger was pulled, but that something caused Mr. Zapruder at that point to wiggle the camera.

Dr. HARTMANN. No, sir. I think we can say that the trigger was pulled, because we see in frame 313 the matter ejected from the head, the head explosion. And in 314 it is flying on up. So if we run it backward—314, 313, 312—the bullet is hitting the head. And then we have to allow about two frames flight time for the bullet.

On that basis I say that the trigger was pulled, a trigger was pulled at 310 plus or minus one. So I would say there must be some sound source starting at 310 plus or minus one.

Now, I would like to work it all the way back to the trigger being pulled, because presumably that is a fixed point in space, as opposed to tying it to impacts on the motorcade which is moving so that we have a firmer fix on it.

So let me say here is a time when there must have been a loud report originating from someplace. Presumably it is the depository, because that matches the acoustic evidence.

Now, the correct number of milliseconds after that, a reasonable number of milliseconds after that, based on the startle reaction, psychological experiments that I quoted from the literature earlier this morning, a reasonable number of milliseconds after that the cameraman starts jiggling. So that makes sense.

Now, the situation is does it make sense up at that end. And in the very broad-brush sense, or if we put on our rosy glasses or diffusing glasses or something, I think you could say yes, the acoustic analysis says there are events up here at this end and the jiggle analysis says there are some events up here at this end, before 200, and not at 210, for example, and not between 210 and 313, which is where the Warren Commission tended to put shots.

So in that sense we have got something new, and we have got some agreement that something is happening up at this end.

And a final sort of broad-brush statement is that I think you will be hearing tomorrow, if I understand, in the testimony sequence quite a bit of interesting evidence, photo evidence, from other members of the photo panel, that a number of very interesting things happen up in here from about 160 or even 150 to about 200—people turning, people who were running along, stopping and looking, this kind of thing, if we watch the crowd action in the background.

So in that sense we have got new results and we have got something that looks interesting and is consistent.

If you now try to get into the detailed fitting of this jiggle pattern to one of these sounds, I think it gets a little bit more difficult.

There probably are several things to be remembered about that. One is there is some uncertainty attaching to the fixing of these times, as I understand it. Maybe a couple of tenths of a second.

That is what is meant when I drew these things as kind of fuzzy bars, that they are not just precise fixed instants. So you maybe get to slide this a little bit.

Maybe I can slide this one around our 310 fiducial mark. And the more I push it, the more unhappy the acoustic people would get presumably. But I can push it a little bit in that direction, and that moves it a little bit up in front of this jiggle, and that makes sense.

The other thing that you can consider is, is it possible that either the movie camera or the tape or both are running at a slightly different time rate than what we timed them.

The camera has always traditionally been timed at 18.3 frames per second. But could that be 19 or 17, something like that?

Mr. PREYER. Could it have been running at that speed that day?

Dr. HARTMANN. We don't really know the answer to that. But that correction would have the effect not of shifting by the small

uncertainty, but by pretending this thing was drawn on rubber and allowing you to stretch it or compress it by a small amount.

We have put our heads together about this and have thought that perhaps 8 percent or something like that might not be unreasonable. And that would get you another 10 frames or something like that up at this end.

So that you could imagine possibly stretching this thing so that these things moved another 10 frames forward. If you did that, then you could start making a case that this shot initiated this jiggle cluster, perhaps even this shot initiated this jiggle here. It would be interesting to see. But we don't have any data, it is not here.

I might also just make a final comment, that all of this would make people who have looked at the previous assassination material I think be surprised, because no one has ever really considered very much the idea that there could be shots that early in the parade.

And I think the basis of that is you look at the parade and at first glance, the first 50 times you look at the Zapruder film you don't see very much happening there.

But I would ask you to listen and see what is discussed, I believe, tomorrow.

Mr. PREYER. Well, is the jiggle analysis consistent with the firing of four shots or is it inconsistent with that?

Dr. HARTMANN. I would be inclined to say that it is perhaps somewhat more consistent with the firing of three shots, without this one. It would perhaps even be more consistent with the firing of two shots, because there are two principal clusters here. I think it is rather weak evidence to answer that question right off.

Mr. PREYER. So it is more consistent with the firing of three shots.

Dr. HARTMANN. Slightly.

Mr. PREYER. But it is most consistent of all with the firing of two shots.

Dr. HARTMANN. I think it would be somewhat more consistent with the firing of two shots. I think this whole mass of material from today gains its credibility by being fitted together with everything else, rather than just being taken as evidence that proves anything on its own.

Mr. PREYER. How much of the reaction is there from Mr. Zapruder seeing President Kennedy struck and reacting, and how much is his jiggling from the sound of the bullet?

Dr. HARTMANN. I think it is impossible to say for certain because we don't know how the human body really reacts. But Mr. Zapruder said that he reacted to the sight of the impact, of the head wound, as I understand it. And that certainly is consistent with this massive shaking that goes on after that.

By psychological experiments that have been done in the past, one would expect that in the first few tenths of a second, though, there would be a startled reaction, and that is probably what we see particularly in frame 318, the very blurred frame.

Mr. PREYER. Thank you, Mr. Chairman.

Chairman STOKES. The time of the gentleman has expired. The gentleman from Connecticut, Mr. McKinney.

Mr. McKINNEY. No questions, Mr. Chairman.

Chairman STOKES. The gentleman from Connecticut, Mr. Dodd.

Mr. DODD. Thank you, Mr. Chairman.

You stated in response to Congressman Fithian's question that the Warren Commission was in error in identifying frame 210 as the frame in which the first gunshot was fired. What is your explanation for the Warren Commission's error?

Dr. HARTMANN. Well, I don't know that I said so flatly that they were in error. But I would say that that evidence does not fit very well with what we have.

And again, my understanding was that the process of logic that they used was they had some testimony that it looked like the wound occurred at about 210, when the President was behind the sign, and that is marked on this little set of keys up at the top.

And then the process of logic continued by saying "We think that—we know from the measurements that the car was behind the general body of the tree shortly before that."

And they felt that that was a less likely time for the assassin to have fired, although there is a gap that they commented on themselves in the foliage of the tree that occurs at about 186. And I think those were the two key bits of testimony.

I am not certain that that is all of the testimony. But I think that is basically why they concluded that.

And as I mentioned before, I am not aware that they did any of this kind of analysis, nor did they look very seriously, I believe, at the early frames. And in fact if you look in your Warren volumes, they start the Zapruder sequence, it was something like 177 or somewhere in the 170's. So that everything before here isn't even in the final volume that was published.

Mr. DODD. Well, based on what you have been telling us here, it would seem to indicate that we place the first shot in about eight frames, at least eight frames earlier than that, around 200, 202.

Dr. HARTMANN. I think a shot probably even before that. If I went through the little mathematical exercise of subtracting a reasonable number of frames from the reaction time, from this cluster, the answer that I got was a shot something like 179 to 195.

Mr. DODD. To your knowledge, looking from the placing the Presidential limousine and being in the Book Depository, where is that tree in that frame?

Dr. HARTMANN. You would be looking through the tree. Although as I mentioned there is a break in the foliage at 186. And I made kind of a quick comparison of some of the photographs that were in the Warren volume, and the foliage measurements were made on the basis of the tests that were conducted the next spring.

And the point has been made, and I am—the point has been made in some of the literature, and I am inclined to believe it after looking at the pictures that were taken on the 22d of November and the pictures that were taken next spring, that there was probably less foliage on the tree on November 22. So that if anything the marksman might have had a larger opening at 186.

So I am inclined not to think that that is a fatal objection to a shot having been made at this time and hitting the target.

Mr. DODD. In response to Judge Preyer's questions with regard to the number of shots, possible number of shots—and I realize that

you are not advocating that this jiggle test is necessarily the best way to corroborate that——

Dr. HARTMANN. No, I am not.

Mr. DODD. But to make the point, Dr. Barger indicated that two of the shots could have occurred within five-tenths of a second of each other. And I presume what you are telling me is that it would be impossible, based on jiggle analysis, to determine whether or not there was one or two shots within that short a frame, a time frame.

Dr. HARTMANN. I think it would be very difficult to tell. You see the kind of problem that you would get into, if we just take any of this pattern of jiggle back here toward the end of the diagram, it would be hard to pick two of those spikes out and say those are related to these two noises. So I don't know what the evidence would be.

Mr. DODD. Thank you. Thank you, Mr. Chairman.

Chairman STOKES. Mr. Fithian, anything further?

Mr. FITHIAN. Nothing, Mr. Chairman.

Chairman STOKES. OK. Dr. Hartmann, under the rules of our committee any witness at the conclusion of his testimony may have 5 minutes in which to expand upon his testimony before the committee in any way. I would like to extend to you 5 minutes if you so desire.

Dr. HARTMANN. Just to make the point very briefly that it has occurred to me that perhaps sometimes a scientist making the measurements of these films comes across as very coldhearted. I comment at least for myself, and I think many of us, that the horror of this thing came across many, many times in doing this. And I wish you all very much good wishes to clarify what really has happened here.

Thank you.

Chairman STOKES. Thank you very much, sir.

There being nothing further, these hearings are adjourned to 9 a.m. tomorrow morning.

[Whereupon at 6:15 p.m. the hearings were adjourned to reconvene at 9 a.m., Tuesday, September 12, 1978.]