

**Report No. 4034**

**Analysis of Earwitness Reports Relating to the Assassination  
of President John F. Kennedy**

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## 1. INTRODUCTION

The analysis of witness reports comprised (1) an examination of two compilations of testimony given by witnesses present in Dealey Plaza on November 22, 1963, (2) an analysis of how the sounds of gunfire in Dealey Plaza would be perceived by witnesses located at different areas in the Plaza, and (3) the reports of trained listeners who were present during the acoustical reconstruction on August 20, 1978. The two compilations examined were those by J. Thompson, in his book, *Six Seconds in Dallas*, and by members of the staff of the House Select Committee on Assassinations.

All earwitness reports, whether of those present in Dealey Plaza in 1963 or of the experienced listeners in 1978, must be examined with an understanding of the characteristic acoustical behavior of gunfire in a reverberant space. Section 2 of this report explains how listeners can misjudge the source and number of shots in such a space. Section 3 reports the analysis of the two compilations mentioned above; Sec. 4 details the observations of trained listeners stationed in the Plaza during the acoustical reconstruction.

## 2. LOCALIZATION OF SOUND

The nature of gunfire is such that three basic errors in judgment relating to the source and the number of shots are possible:

- confusion of the shock wave and the muzzle blast
- front-back reversals
- misjudgment of interfering echoes.

The acoustic stimulus, or shot, has two primary components: the shock wave and muzzle blast (illustrated in Fig. 1); and several echoes, or reflections.

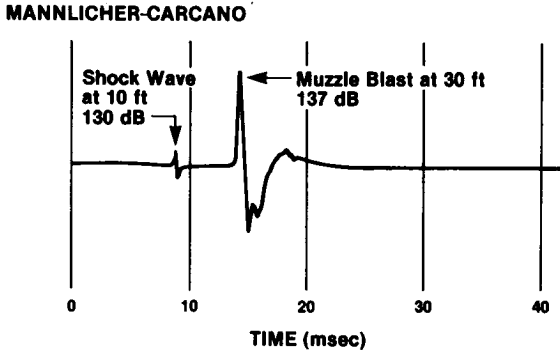


FIG. 1. MUZZLE BLAST AND SHOCK WAVEFORMS FROM MANNLICHER-CARCANO.

Because a rifle bullet travels at supersonic speed, it generates a shock wave that spreads acoustically in the shape of a cone, with the bullet as the tip of the cone. The muzzle blast, which propagates at the speed of sound, spreads out spherically from the source. Both of these sounds are very loud. The shock wave has a peak sound pressure level of about 135 dB re  $2 \times 10^{-5} \text{N/m}^2$ , and the muzzle blast, a peak of 157 dB re  $2 \times 10^{-5} \text{N/m}^2$ , at 1 m. The time between arrivals of these two sounds at a given listener location can vary considerably, depending on the listener's position with respect to the location of the rifle and the path of the bullet. Since the amplitude of the shock wave diminishes as one over the distance from the source and the amplitude of the muzzle blast diminishes as one over the square of the distance from the source, the relative intensity of these two sounds also varies considerably from one listener location to another.

At any reasonable distance, both the conical and spherical waves are essentially plane waves with respect to a small object such as an observer's head. Thus, to determine the *apparent* locus of the source, we need only take a perpendicular to the appropriate wavefront as it sweeps over the observer. Figure 2 shows the geometry of the two waves at two different times. The shock wave, at time 1, has just reached the observer; its apparent locus is along the path of the bullet on a perpendicular to the shock wave. At this time, the wave from the muzzle blast has not reached the observer. At time 2, when the blast wave has reached the observer, the apparent source of the shot is on a perpendicular to the plane of the spherical blast wave and, therefore, at the muzzle of the rifle.

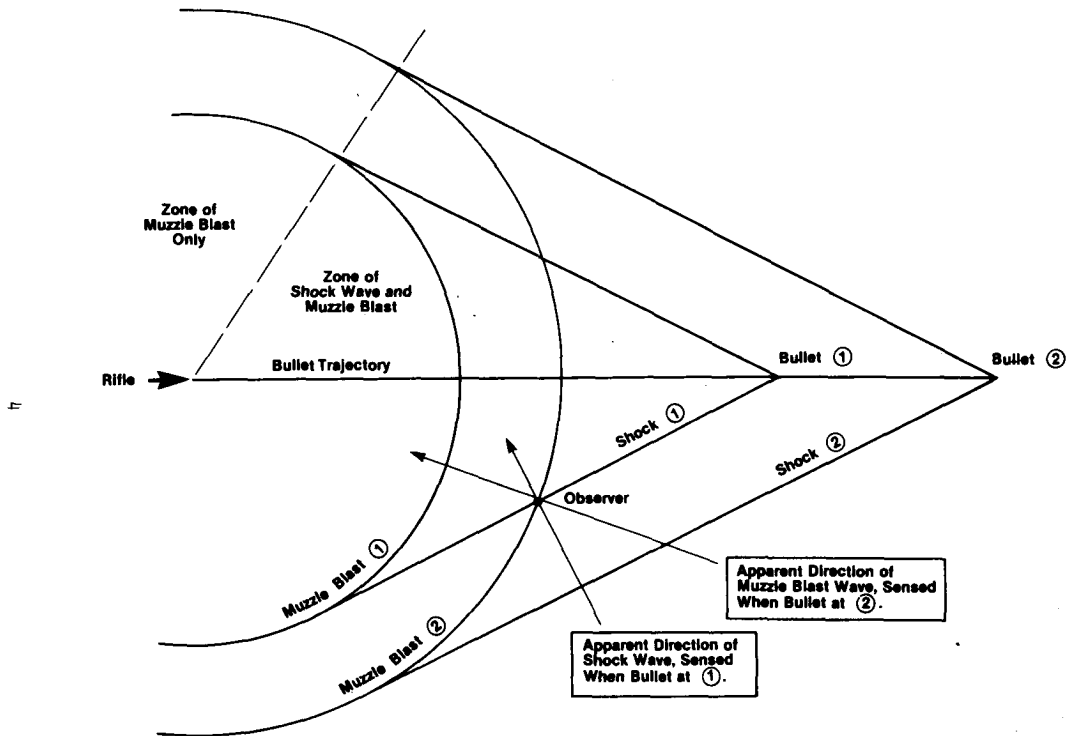


FIG. 2. LOCI OF MUZZLE BLAST AND SHOCK WAVES AT TWO TIMES AFTER FIRING OF SUPERSONIC BULLET.

Dr. George Garinther confirmed this analysis at a test carried out with 20 to 30 observers at the Aberdeen Proving Ground. The observers were seated in rows parallel to the path of the bullet. The blast wave was muffled by firing the rifle through a small hole in an enclosed van. The reports of the observers are portrayed graphically in Fig. 3. About 75% of the observers pointed at the path of the bullet, while 25% pointed away from this path - but still perpendicular to the surface of the conical shock wave.

This latter judgment is called a front-back reversal. If the sound of the shock wave were not so brief, an observer would have time to execute a head motion and tell whether the source was exactly in front of or behind him. However, the shock wave endures for only about 1 msec and the blast wave about 5 msec; some front-back reversals are therefore expected. Even if the muzzle blast is not silenced, the observer may be confused. The further the observer stands away from the muzzle and the nearer the path of the bullet, the more likely that localization of sound will be based on the shock wave and, hence, incorrect.

Some muffling of the blast wave will occur if a rifle is fired from within an open window. Thus, in the acoustical reconstruction, the rifle was fired from two locations in the TSBD: (1) in the plane of the open sixth-floor window and (2) with the muzzle tip withdrawn 2 ft from the plane of the window.

The buildings around the Plaza caused strong reverberations, or echoes, that followed the initial sound by from 0.5 to 1.5 sec. While these reflections caused no confusion to our listeners, who were prepared and expected to hear them, they may well have



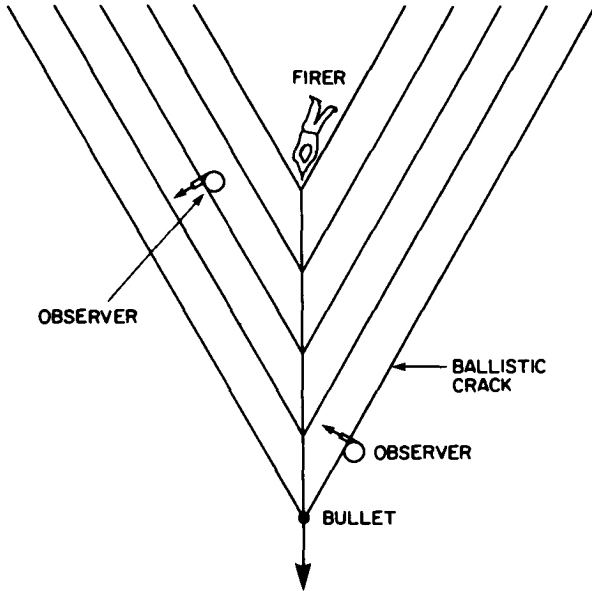


FIG. 3. OBSERVERS LOCALIZING SOURCE OF SOUND ALONG PATH OF BULLET.

inflated the number of shots reported by the suprised witnesses during the assassination. The source of these echoes can be predicted from the general geometry of the Plaza. For example, one hears a very strong reflection from the Post Office Annex that arrives about 1 sec after the shot, regardless of whether the rifle is fired from the TSBD or the knoll. Because of the long delay, a listener located on the knoll would recognize this as an echo but might place the source somewhere in back of him, anywhere from the TSBD to the railway overpass.

From near the TSBD, a listener would hear a strong echo from the general vicinity of the railway overpass. However, since the initial disturbance, the shock wave from the bullet, would be almost directly overhead - an anomalous locus, especially if the rifle had been fired from well within the TSBD - this echo would cause some confusion. The general area of the knoll, to the right of the bridge, would then be a prime candidate as the locus of the source. Even though this echo occurs 0.8 sec after the shock wave, it is the first sound that would make sense to the listener. On the other hand, listeners located near the railroad overpass would react to the very strong reflections from along Houston St.

For listeners in the Plaza area, the location of the rifle muzzle relative to the window opening is a critical determiner of the perceived sound. The further inside the building the muzzle is located, the greater the potential for the shock wave to dominate perception. If the muzzle of the rifle had been withdrawn and, therefore, little or no blast were present for one or more of the shots in 1963, the localization judgments of people in the Plaza would have been based primarily on the shock wave, creating much uncertainty and lack of agreement.

During the reconstruction, echoes were heard from the new hotel, but they arrived some seconds after the primary sound and long after the earlier echoes from structures bordering the Plaza. The hotel echoes, therefore, did not interfere with the subjective evaluations in any way.

## 3. STATISTICAL SURVEYS

## 3.1 Origin of Shots

According to Investigator J. Basteri, 692 people were present in the Plaza during the assassination. Two surveys of interviews and testimony given by some of these people have classified the witness reports as to the origin of gunfire into four categories: the TSBD, the Knoll, Other (not TSBD or Knoll), and Don't Know (origin uncertain). J. Thompson's compilation in *Six Seconds in Dallas* of 190 witness reports is summarized in Table I.

TABLE I. THOMPSON'S ANALYSIS OF ORIGIN OF SHOTS.

TSBD	Knoll	Other	Don't Know	Total
25	33	6	126	190
13.2%	17.3%	3.2%	66.3%	100%

This sample of 190 is 27.4% of the total available witnesses. It is difficult to know what, if any, bias is present in the selection of these witnesses. The sheer size of the sample makes it difficult to believe that a sizeable selection bias was present. It is also difficult to predict the effect of a selection bias, if one were present. How could one tell what the witness was likely to report prior to the interview? People were scattered over a large area of the Plaza, but we do not know if equal proportions were selected from each area. This factor could influence the results, since analyses reveal that a person located near the knoll was more likely to report the knoll as the origin of the shots than any other location; similarly, a person located near the TSBD was more likely to report the TSBD as the origin of the shots than any other location.

The House Committee compilation is drawn from witness interviews by the Dallas Police Department and the FBI and from sworn testimony in the Warren Report. The total number of reports in this survey is 178. With very few exceptions, all these people appeared in the 190 sampled by Thompson. Similar sample-selection uncertainties apply here as well. The House Committee analysis is summarized in Table II.

TABLE II. HOUSE COMMITTEE ANALYSIS OF ORIGIN OF SHOTS.

TSBD	Knoll	Other	Don't Know	Total
49	21	30	78	178
27.5%	11.8%	16.9%	43.8%	100%

Over half the sample had some opinion as to the origin of the shot; the majority of these reported the origin as the TSBD. Twenty-one witnesses reported the Knoll as the source, 30 reported some other location, and only 4 witnesses gave more than a single location for the shots. The four reporting a dual or multiple location are counted as "Other" in Table II. Of the 49 witnesses pointing at TSBD, 13 were at the depository itself, 16 were in the motorcade, and the remainder were scattered throughout the area, including at the Sheriff's Office, the overpass, the knoll, and the triangular park.

A breakdown of these reporting the knoll as the origin of the shots show that 2 of 21 were located on the knoll. Eight were on the curb along Elm St. on the knoll side or on that side of the motorcade traveling down Elm St. Four were near the TSBD. One was on the east side of Houston. Five were in

the triangular area bordered by Elm, Houston, and Main, and one was on the railroad overpass.

An analysis of the "Other" responses showed no obvious pattern. Some witnesses at the TSBD point toward Houston St.; others point down Elm. Similarly, those at the Sheriff's Office point in an arc ranging from west of TSBD to the railroad overpass.

Comparing this statistical analysis with Thompson's, the most striking discrepancy is the relatively low percentage of witnesses reporting origins other than the knoll or the TSBD in Thompson's compilation. Another important difference is in the relative number of people pointing at the TSBD vs the knoll. Although the categorization of a given response is somewhat arbitrary, the major discrepancy in the two compilations must be laid to a difference in classification of responses making up the compilations. Zapruder is listed in the Thompson survey as pointing to the knoll, while his sworn testimony before the Warren Commission was as follows:\*

Liebeler: But you didn't form any opinion at that time as to what direction the shots did come from actually?

Zapruder: No.

Hence, House Committee staff placed his response in the "Don't Know" category.

### 3.2 Number of Shots

The House Committee compilation also categorized witness responses according to number of shots attributed to the four

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\*Warren Report, Vol. 7, p. 572.

different categories of origin. This analysis is summarized in Table III.

TABLE III. NUMBER OF PEOPLE REPORTING VARIOUS ORIGINS AS A FUNCTION OF THE NUMBER OF SHOTS REPORTED

Reported Origin of Shot	No. of Shots Reported					Total
	2	2 or 3	3	4	Don't Know	
TSBD	3 (4.5)*	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)	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 <sup>†</sup>

\*Expected number of judgments if origin and number of shots are independent judgments.

<sup>†</sup>Seven other witnesses report 1, 4-5, 5, 6, or 8 shots.

Reports as to the number of shots range from 1 to 8. Of the 178 witnesses, however, the vast majority, 74.2% (132/178), reported 3 shots, and the mean number reported was 2.98.

Given the scatter in the reported sources of the gunfire, one tenable hypothesis is that only people in certain locations might hear the knoll shot. We therefore sought to investigate to what extent the data matrix was interrelated, i.e., to what extent does one judgment influence the other? One test for

this interrelation is to assume the converse - namely, that the judgments are independent and to determine how well we can predict the entire data matrix on the basis of this hypothesis. The expected number, which is given in parenthesis beneath the number of people actually reporting, is calculated by determining the probability of each report from the margins and assuming that a particular cell, the intersection of that row and column, can be calculated from the product of the probabilities. For example,  $20/171 = .117$  report the shot coming from the knoll and  $132/171 = .772$  reported 3 shots. Thus, the joint occurrence of both events, assuming they are independent, is  $(.772) (.117) = .09$ , and the expected number of such reports is  $(.09) (171) = 15.4$ . The number of people reporting shots in this cell of the matrix is 11, 4 or 5 fewer than expected. By and large, the predictions are excellent, and there is no reason to suspect that the two responses are other than independent.



#### 4. REPORTS OF TRAINED OBSERVERS

On August 20, 1978, Dr. Dennis McFadden of the Psychology Department of the University of Texas and Dr. Frederick Wightman of the Department of Audiology at Northwestern University listened to the three sequences of shots fired during the acoustical reconstruction and recorded their impressions. Appendix A contains a transcription of their notes. Their reports concerned the apparent origin of shots, any apparent secondary sources or echoes, how loud the shots were, and any other remarks they felt appropriate.

Initially, we were uncertain as to how easy it would be to determine the correct location and what degree of consistency there would be among the observers. Hence, for the first sequence, and during most of the second, the observers were located about 1 m apart and in such a way that I could see and compare their responses. The approximate observer locations for each sequence are indicated in Fig. 4. During the first sequence, Dr. Wightman correctly localized all 17 shots, and Dr. McFadden missed only 1. Their general qualitative descriptions and descriptions of the reverberations were also highly consistent. We were, therefore, more confident about the consistency of the reports, and during the latter part of the second sequence, Dr. McFadden moved from his original location at the curb at the top of Elm directly in front of the TSBD, to across Elm on the southwest corner of Elm and Houston. For the third sequence, Dr. Wightman and I observed from the grassy triangle formed by Elm, Houston, and Main Sts., while Dr. McFadden observed from the railroad tracks, above the northern curb of Elm.

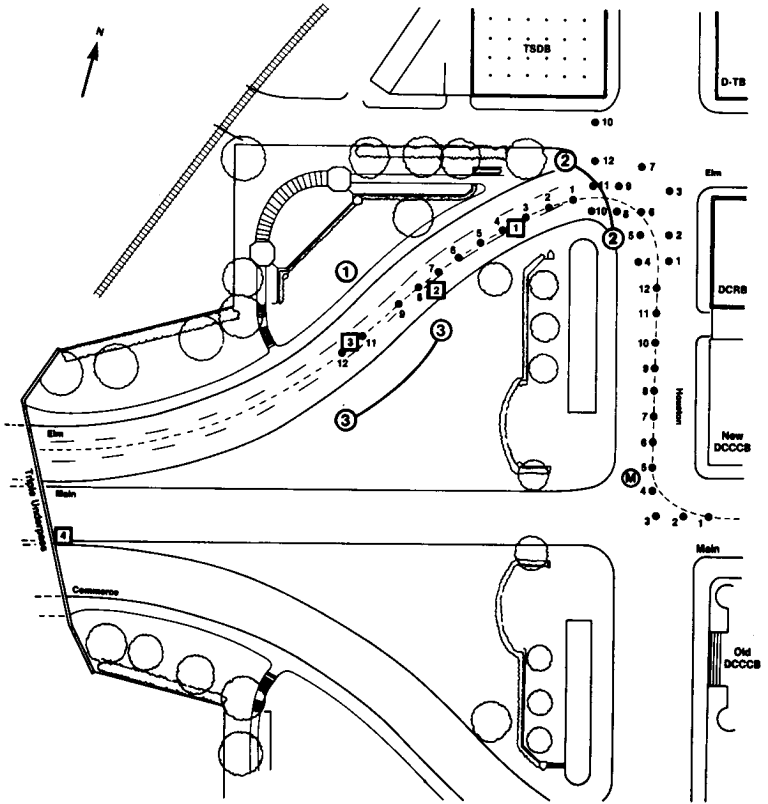


FIG. 4. OBSERVER LOCATIONS AT DEALY PLAZA.

My own impressions and the reports of Dr. William Hartmann, the investigator of the "jiggle analysis," were very similar to those of McFadden and Wightman, although my own hearing is impaired by about 50 dB in my left ear. The primary manifestation of this difficulty was my failure to hear some echoes if they occurred to my left. Thus, it would seem that our observers, because of their special training and experience, are only slightly more acute concerning nuances of the echoes and reverberations and, perhaps, in separating the shock wave and the blast wave than are untrained people.

The emotional condition of our observers during the test and the emotional condition of the people during the assassination were undoubtedly quite different. The influence of such emotion on the localization judgment may be quite large, but there is no way to quantify this factor.

#### 4.1 Test Conditions

The shot sequence was unknown to both of the observers. Because repeats of certain shots were requested during the sequence, I was also uncertain - despite knowing the planned sequence.

We requested three motorcycles to be running during the test to provide some background noise that would approximate the original listening conditions in Dealey Plaza. Unfortunately, these newer motorcycles were not very noisy, but the shots were so loud that any reasonable level of background noise would have been low in comparison with the shots themselves. Our listening conditions were, therefore, essentially representative of those at the time of the assassination, except for our being able to hear some very-low-level, long-delay echoes that originally might have been inaudible.

Our observers *did* know that there were only two possible locations for the marksman, whereas there was considerably more uncertainty on this issue at the time of the assassination. Signal uncertainty of this kind generally does not seriously degrade the accuracy of judgments, but it does depend on the number of potential alternatives. In this case, as we shall see, the localization reports made by the trained listeners were, for the most part, of general areas, rather than specific windows of a building. The total number of potential locations was not, therefore, large and, thus, was likely to be representative of localization responses given at the time of the assassination.

#### 4.2 Analysis of Observers' Localization Responses

The descriptive comments made by the observers are difficult to compare with any degree of precision. However, there was clear agreement in their reports with respect to the apparent loudness of the sounds and echoes and the apparent size of the acoustic image. After each test shot, we asked the two observers to guess whether the shot was fired from the TSBD or the knoll, independent of what the apparent locus might be. Table IV is an analysis of this forced-choice data.

TABLE IV. ACCURACY OF FORCED-CHOICE RESPONSES AS TO ORIGIN (TSBD OR KNOLL)

Sequence	Dr. Wightman		Dr. McFadden	
1	12/12	100%	11/12	92%
2	11/15	73%	14/15	93%
3	19/25	76%	23/25	92%
Overall	47/57	82%	53/57	93%

Overall Agreement 82%

The average accuracy of the reports is nearly 90%, and the consistency between the two observers is 82%. Also, the average accuracy is nearly exactly the same whether the shot came from the TSBD or the knoll. Thus, this analysis shows high accuracy in localizing the source of the sound and reasonably good consistency.

#### 4.3 Loudness and Apparent Size of Acoustic Image

All observers rated the rifle shots as very very loud, and they were unable to understand how they could have been described as a firecracker or backfire. Only the pistol, which was subsonic, produced a moderate loudness.

Practically all the rifle shots, whether fired from the knoll or the TSBD, appeared to be diffuse and to occupy a very large acoustic space. For example, the sound did not seem to come from the sixth floor window of the TSBD, but from the right upper side of the building. This apparently large source location may be a result of acoustic scatter of the muzzle blast - either because of the building in the case of the TSBD or because of the trees in the case of the knoll. Only the pistol shot appears to have a reasonably constrained acoustic image and, for that reason, could be localized with some precision.

One might consider whether silencers would change the apparent loudness or the size of the image. The Garinther-Moreland study\* reports the average attenuation produced by a number of silencers as being about 18 dB for all weapon-silencer combinations. Sound from the supersonic weapons tested were attenuated

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\*"Acoustical Considerations for a Silent Weapon System: A Feasibility Study," 1966, p. 70.

by 18.6 dB and 37.5 dB, but even with this reduction, the peak overpressure was still very large. Two rifle-silencer combinations produced peak overpressures of 138 dB and 120 dB at 3.8 m, clearly loud enough to be easy to locate and clearly audible above the motorcycle and crowd noise.

## 5. CONCLUSIONS

It is difficult to draw any firm conclusions relating the reports of witnesses in the Plaza to the possible locus of any assassin. Confusion between the shock wave and muzzle blast, front-back reversals, confusion caused by echoes, and the startle of the witness could all be used to impeach the testimony of any particular witness. There is no way of knowing which, if any, of these factors was most significant with respect to any single observation made on November 22, 1963. Thus, one witness can be assigned no more credibility than any other. For example, even if a shot was fired from the TSB, the witnesses standing on the knoll would likely report the source of the shot in the following way. The witness would presumably localize on the basis of the shock wave. With the path of the bullet behind the President's car, the witness would perceive the apparent locus of the shot as being on a line from himself to the bullet's path - i.e., in the street or open park behind the path of the bullet. Since this location is impossible, a front-back reversal is likely. This front-back reversal would place the source 180° behind the bullet path and, hence, on the knoll.

Despite this uncertainty, two general remarks seem worthwhile - one based on the test, the other on the statistical analysis.

First, it is hard to believe a rifle was fired from the knoll. Such a shot would be extremely loud, even if silenced, and it would be hard to imagine anyone in the vicinity of the knoll missing such an event. An unsilenced pistol firing subsonic bullets also seems unlikely because this shot was the easiest to localize of all the shots fired. It produced the least reverberation. As an acoustic image, it was much sharper

and less diffuse than that of the rifle, sounding much like a firecracker. It is, however, conceivable that had a pistol been fired from the knoll at about the same time a rifle was fired from the TSB, the pistol shot would have been less easily localized, or even completely masked from some vantage points. As an isolated shot, however, it is extremely easy to localize.

Finally, if one accepts the hypothesis that a marksman fired from the knoll and that other shots were fired from some other location, then it seems most unlikely that only 4 of 178 witnesses would report a single location as the origin of the shots. Despite the various causes of confusion in the locus of any single shot, a second shot from a different location should be distinctive and different enough to cause more than four witnesses to report multiple origins for the shots.



## APPENDIX A. TRANSCRIPTION OF OBSERVERS' NOTES

The tabular information in this appendix was transcribed from notes made during the acoustical reconstruction on August 20, 1978 by two trained observers - Dennis McFadden and Frederick Wightman. Included in this table, along with their responses, are the number of the shot in each sequence of test firing, the origin of the shot, and the target fired upon. For convenience in determining the positions of rifle, target, and listener, the reader may refer to Fig. 4 of this report.

Abbreviations used within the table are as follows:

- T always refers to the TSBD and K to the knoll.
- In the column headed origin,  $T_p$  means the rifle was fired in the plane of the sixth floor window of the TSBD,  $T_2$  means the muzzle was withdrawn 2 ft from the plane of the window, K indicates a rifle shot from the knoll, and  $K_p$  represents a pistol shot from the knoll.

A.1 Observer: Dennis McFadden

Location 1: On grass north of Elm Street in front of Zapruder position

Shot No.	Origin	Target	Forced Choice Response	Judgments	Blast and N-Wave	Comments
1	T <sub>p</sub>	1	T	TSBD Something behind me, too. Long reverberation from south.	?	--
2	T <sub>p</sub>	1	T	TSBD Long reverberation from south.	?	Different quality than No. 1— Less reverberation?
3	T <sub>p</sub>	1	T	TSBD	Yes, sharp crack.	Heard a sharp crack but also muzzle. Acoustically rich?
4	T <sub>p</sub>	1	T	TSBD	Duller thud than No. 3. (Muzzle?)	Long reverberation from south. Somehow not so rich as No. 3.
5	T <sub>p</sub>	1	T	TSBD	Somewhat sharper than No. 4. No obvious crack.	Very rich acoustically. Maybe as many as 4 to 5 echoes, 2 to 3 of them earlier and weaker than strong 1 from south. All reverberations from south.
6	T <sub>2</sub>	1	T	TSBD	No crack.	Very much like No. 5.
7	T <sub>p</sub>	2	T	TSBD	Yes, blast and crack.	Perhaps not so much reverberation from south.

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A.1. (Cont.)

Shot No.	Origin	Target	Forced Choice Response	Judgments	Blast and N-Wave	Comments
8	T <sub>2</sub>	2	T	TSBD	Yes, blast and crack.	<i>Very much</i> like No. 7.
9	K	2	K	Over my head. Not really on Knoll or even behind me.	No, not a sharp crack, blast and N-wave blended.	One massive experience. No clear reverberation from south.
10	T <sub>P</sub>	3	T	TSBD	Yes. Crack.	Long reverberations from south.
[TSBD as a response means only "to the left"; impossible to localize at sixth floor window; diffuse origin.]						
11	T <sub>2</sub>	3	K	Multiple locations. Overhead kind of toward court house on Houston.	Yes. Crack primarily.	Single sharp sound initially plus reverberation. Most firecrackery sound so far.
12	K	3	K	To the right on the Knoll with absolutely <i>no</i> question.	No crack.	Made me jump. Very loud compact sound. No obvious reverberations.
13	K <sub>P</sub>	3	K	To the right on Knoll.	No. Pistol, I guess.	Kind of firecrackery but a little too long. Much less loud. No obvious reverberations. Localization judgments are probably being affected by knowledge of source. Also an experience of it being high in air over toward blue hotel.

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A.1 (Cont.)

Shot No.	Origin	Target	Forced Choice Response	Judgments	Blast and N-Wave	Comments
14	K <sub>P</sub>	3	K	To the right Knoll/underpass	No.	Just like No. 13. Single compact, high-frequency sound. No obvious reverberations.
<p>[These last two pistol shots from Knoll sounded to our right, but not so obviously from behind] as did No. 12; No. 13 and No. 14 were more like from overpass.</p>						
15	T <sub>P</sub>	4	T	TSBD (No motorcycle on for No. 15.)	Yes, I think so. Certainly was a sharp report.	Very sharp report. Minimal reverberation. Just a couple of echoes.
16	T <sub>2</sub>	4	T	TSBD Sound definitely began at TSBD.	Definitely yes. Muzzle followed by very sharp crack.	Pretty good reverberation. 3 to 4 good echoes.
17	K	4	K	On Knoll pretty far behind me. Pistol?	Uncertain. Maybe just N?	Big "pop." Sounded like large pistol rather than rifle. Not clear about reverberation. Think there was an echo located over by truck.

[Truck was then on NW corner of Main and Houston, pointed west on Main.]

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A.1 (Cont.)

Location 2: *On sidewalk on north side of Elm, across east-west side street (also Elm?) from TSBD*

Shot No.	Origin	Target	Forced Choice Response	Judgments	Blast and N-Wave	Comments
1	T <sub>P</sub>	1	T	Directly overhead.	No. Just one massive and diffuse sound.	One big shock. Couple of very weak reverberations following it. Long delay. Totally different from Location 1.
2	T <sub>2</sub>	1	T	Overhead - not directly though.	--	Sharper than No. 1. Localized kind of down front of TSDB because I had my head turned down Elm talking.
[This is the east-west Elm in front of TSBD.]						
3	T <sub>2</sub>	1	T	Overhead	No.	Somewhere between No. 1 and No. 2 in sharpness.
4	T <sub>P</sub>	2	T	Overhead and to some degree on overpass. Right down the street (Elm).	No, one big sound.	Stronger and longer delay reverberations than previous couple of shots.
5	T <sub>2</sub>	2	T	Overhead	No, one sound.	Very much the same as No. 4.
6	K	2	K	Knoll area Pistol?	Pretty much a crack. Not a firecracker though.	3 to 4 good echoes from behind me. From TSBD.

A-5

## A.1 (Cont.)

Shot No.	Origin	Target	Forced Choice Response	Judgments	Blast and N-Wave	Comments
7	T <sub>P</sub>	3	T	Overhead	No, single sound.	Besides echoes from blue hotel area, got a good one from my left (down Houston St.) that wasn't delayed very long.
8	T <sub>2</sub>	3	K	Hard to tell. Knoll area but more to <i>right</i> of it. In gazebo thing.	--	--
9	K	3	K	Definitely Knoll. Pistol?	Compact thud.	Little reverberation if any.
10	K <sub>P</sub>	3	K	Knoll Pistol?	Brief "pop." Weakest source so far.	Firecrackery except a little too long and a little too low frequency.
11	K <sub>P</sub>	3	K	Knoll Pistol again. Re-do of 10.	Pop gun! Same as 10 except ... (didn't finish this)	We had crossed street and gone to stand in front of truck over by court house for this trial only.
12	T <sub>P</sub>	4	T	Down Elm. Also along front surface of TSEB (to our right rear).	? No. All pretty much 1 sound.	Loud, dense sound. Some rapid reverberation.

A-6

A.1 (Cont.)

Shot No.	Origin	Target	Forced Choice Response	Judgments	Blast and N-Wave	Comments
13	T <sub>2</sub>	4	T	--	Muzzle and very sharp crack.	Crack seemed high in air and down along front surface of TSBD (to our right rear).
<p>[For the next two shots I was across the street, crouched down near "The Brennan Position" with Bill Hartman. He had indicated that he heard a clear "double sound" from that location on previous shots, and D.M. Green sent me there to check on Hartman's report. My experience was much in accord with Hartman's; and from that spot the muzzle blast was muted somewhat, the rich reverberations so obvious from Location 2 were generally absent, and there was a clear "double-thud" and/or "triple-thud" quality to the shot.]</p>						
14	K	4	K	"Brennan Position"	--	Muzzle from Knoll area and then marked second and third report from northeast.
15	K	4	K	Knoll "Brennan Position"	No	2 marked fronts. Muzzle and then echo from Mel Rose Bldg.

A-7

[Exact head location clearly very important back behind this wall, for in No. 14 I heard more than one echo (less than about 750 msec) and in No. 15 I heard only one. In between, I had moved my body and head.]

A.1 (Cont.)

Location 3: On underpass over the most southerly lane of Elm.

Shot No.	Origin	Target	Forced Choice Response	Judgments	Blast and N-Wave	Comments
1	T <sub>p</sub>	1	T	Definitely TSBD area, <i>not</i> Knoll. To right slightly of TSBD; from juncture of 3 buildings at corner of Elm and Houston.	No, single blast.	Got a rapid echo off court house (on corner of Houston and Main).
2	T <sub>p</sub>	1	T	Definitely TSBD area.	No, single blast.	A little more diffuse in locus than No. 1.
<p>[From this location for the first two targets I frequently heard numerous, reasonably strong echoes off the fronts of the buildings lining Houston St. (Records Bldg. and Court House). Often there was an impression of them running off in rapid sequence from north to south. Not so for target on Main St. See below.]</p>						
3	T <sub>2</sub>	1	T	Definitely TSBD area.	No crack.	Some good echoes. 3 to 4 from Houston St. bldgs.
4	T <sub>p</sub>	2	T	Definitely TSBD.	--	Much louder than previous shots. More echoes too. 5 to 6 all within 1 second or so. Also got some echo from behind (blue hotel) but it wasn't here then (in 1963).

A-8



A.1 (Cont.)

Shot No.	Origin	Target	Forced Choice Response	Judgments	Blast and N-Wave	Comments
5	T <sub>2</sub>	2	T	TSBD	Yes. Crack and muzzle	Much more of a crack. Many echoes from Houston St. bldgs.
6	K	2	K	More toward Knoll but <i>not</i> markedly so.	Quieter than previous.	Not like it was way to my left.
<p>[ This last comment was meant to indicate my uncertainty as to the origin of the shots heard from this location. I <i>knew</i> some were supposed to be from Knoll and some from TSBD, but none seemed to be coming from Knoll. No. 6 seemed to be different in its origin from previous ones, but it didn't really localize at the Knoll, just more to the left, more towards the Knoll, than the previous shots. The feeling of uncertainty persisted. ]</p>						
7	T <sub>P</sub>	3	T	TSBD	Some crack. Not so loud as some previous TSBD shots.	Plenty of reverberation.
8	T <sub>2</sub>	3	T	TSBD? Not clear. Kind of between Knoll and TSBD.	Some crack.	Reverberation weak.
9	K	3	K	Knoll? Not really confident.	More blast than ____.	Coming too fast to get thoughts straight and reactions written.

A-9

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## A.1 (Cont.)

Shot No.	Origin	Target	Forced Choice Response	Judgments	Blast and N-Wave	Comments
10	K <sub>p</sub>	3	K	Knoll definitely. Pistol?	Weak sound.	Little reverberations. I think the uncertainty about Knoll localization with rifle shots may be (due to a) short, strong reflection off TSBD bldg. directly behind it (Knoll). This one, if it <del>was</del> a pistol was much more compact and easily localized.
11	T <sub>p</sub>	1	T	TSBD definitely.	Compact sound.	Acoustically rich. Most marked echoes from behind me off blue hotel.
12	T <sub>2</sub>	1	T	Again, definitely TSBD corner.	Compact sound.	Early echoes not really strong, but present. Stuff comes (off of) front of Houston St. bldgs.
13	T <sub>p</sub>	2	T	Same as No. 12? Pretty small focus of localization.	--	<i>Very much</i> like No. 12.
14	T <sub>2</sub>	2	T	Same as 13? Small focus. Right at corner Elm and Houston.	--	--
15	K	2	T	TSBD	--	<i>Much</i> sharper early echoes off Houston St. bldgs.

A-10

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A.1 (Cont.)

Shot No.	Origin	Target	Forced Choice Response	Judgments	Blast and N-Wave	Comments
16	T <sub>P</sub>	3	T	TSBD? Maybe Knoll.	Compact sound not as loud as some.	--
17	T <sub>2</sub>	3	T	Same as No. 16.	Same as No. 16.	Most marked echoes from ... (see below)
18	K	3	K	Knoll?	Compact.	Good echo off post office. Not so obvious off Houston St. bldgs.

No. 16, No. 17, No. 18, all came fast and my writing lagged behind them.

[Remainder of shots taken at target on south curb of Main St. which was to my right (south). With exception of No. 19 (during which I was writing and my head was averted) all of these shots aroused very distinct impressions of a source due east, directly down Main St. I was clearly using only the N-wave and ignoring the blast.]

19	T <sub>P</sub>	4	T	TSBD? (Had head down and averted at time of this shot.)	Good crack. Some muzzle too.	Echo off post office.
20	T <sub>P</sub>	4	T	Localized on N-wave right down Main St.	Good crack. No muzzle.	--
21	T <sub>2</sub>	4	T	Same as 20.	Louder somehow?	--
22	K	4	T	Same as 20 and 21.	Very good crack.	--

A.1 (Cont.)

Shot No.	Origin	Target	Forced Choice Response	Judgments	Blast and N-Wave	Comments
23	T <sub>p</sub>	4	T	Same as above.	--	Some reverberation off post office and blue hotel.
24	T <sub>2</sub>	4	T	Right down N-wave. Right down Main St.	Good crack.	--
25	K	4	K	More to left toward TSBD and/or Knoll but not really at it. More from court bldg.	Very full sound (long and low-frequency I guess I mean).	--

A-12

A.2 Observer: Fred Wightman

Location 1: On grass north of Elm Street in front of Zaprunder position

Shot No.	Origin	Target	Forced Choice Response	Apparent Source Description	Secondary Choice	Reverberations	Loudness
1	T <sub>P</sub>	1	T	TSBD	across st.(3) PO	3 or 4	High
2	T <sub>P</sub>	1	T	TSBD	across st.(3) PO	3 or 4	High
3	T <sub>P</sub>	1	T	L of TSBD	across st. PO	3 or 4	High
4	T <sub>P</sub>	1	T	TSBD	PO	3 or 4	High
5	T <sub>P</sub>	1	T	TSBD	PO	3 and 4	Sharper than 1 to 4, sharp echoes 3 or 4, then big echo, echoes from concrete st. in plaza.
6	T <sub>2</sub>	1	T	TSBD	PO	3 or 4	About like 5, but duller.
7	T <sub>P</sub>	2	T	TSBD	PO	Crack at beginning	Sharp.
8	T <sub>2</sub>	2	T	TSBD	--	--	Same as 3.
9	K	2	K	Knoll - to right (of FW)	--	--	--

A-13

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## A.2 (Cont.)

Shot No.	Origin	Target	Response	Apparent Source Description	Secondary Choice	Reverberations	Loudness
10	T <sub>P</sub>	3	T	TSBD	--	Sharp crack at beginning.	A little duller than 7.
11	T <sub>2</sub>	3	T	TSBD	PO	--	Sharpest, smallest.
12	K <sub>P</sub>	3	K	Knoll to right (of FW).	None.	--	Loud, dull, large sound.
13	K <sub>P</sub>	3	K	Knoll	None.	Little.	Cracker-like, thin, little reverb, though crackly.
14	K <sub>P</sub>	3	K	Knoll - underpass from south of Knoll.	--	Little.	Firecracker-like.
15	T <sub>P</sub>	4	T	TSBD	2 - PO plus new hotel.	--	Crack.
16	T	4	T	TSBD	In front - the reverbs only.	--	Dull, hollow, big.
17	K	4	K	Knoll	Was looking in Knoll direction.	--	Loud, dull, large sound.

A-14

A.2 (Cont.)

Location 2: On sidewalk on north side of Elm, across east-west side street (also Elm?) from TSBD

Shot No.	Origin	Target	Forced Choice Response	Apparent Source Description	Secondary Choice	Reverberations	Loudness
1	T <sub>P</sub>	1	T	TSBD (above and behind)	No reverb to speak of.	--	Big blast, no crackling shock wave felt.
2	T <sub>2</sub>	1	T	TSBD and in front	--	--	Less blast, strong echoes from in front.
3	T <sub>2</sub>	1	K	Knoll and TSBD (equal)	--	--	Blast - very diffuse.
4	T <sub>P</sub>	2	K	Knoll	--	--	Strong, higher pitched blast
5	T <sub>2</sub>	2	T	Overhead - toward Knoll.	--	--	--
6	K	2	K	Knoll	2 shots clearly separate	--	Little blast origin of 2nd, not clear, small sources.
7	T <sub>P</sub>	3	K	Knoll and	2 echoes 1 above - one in front left.	--	Big blast.
8	T <sub>2</sub>	3	T	Above and right (not clearly TSBD but not as clearly Knoll as 4 and 6).	--	--	Blast

A-15

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## A.2 (Cont.)

Shot No.	Origin	Target	Forced Choice Response	Apparent Source Description	Secondary Choice	Reverberations	Loudness
9	K	3	K	Single dull blast from Knoll - no confusion.	No reverb at all - quite a thud.	--	Dull blast.
10	K <sub>p</sub>	3	K	Knoll, almost behind arc-like structure Firecracker-like "smallest" source of all.	--	--	--
11	K <sub>p</sub>	3	K	Knoll to left of arc-like structure no question-precise localization. Firecracker-like small source.	--	--	--
12	T <sub>p</sub>	4	T	Above and toward Knoll. Reverb from new hotel strong blast or shock wave.	--	--	--
13	T <sub>2</sub>	4	K	Knoll, above several reverb, sharp blast - higher pitch. 1 strong "twig-snap" after 300 msec.	--	--	--

A-16

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A.2 (Cont.)

Shot No.	Origin	Target	Forced Choice Response	Apparent Source Description	Secondary Choice	Reverberations	Loudness
14	K	4	K	Knoll, lots of reverb dull blast	--	--	--
15	K	4	K	Knoll about like 13, sharper blast			

*Location 3: On underpass over the most southerly lane of Elm.*

1	T <sub>p</sub>	1	T	TSBD 6th floor	--	--	Prom. blast
2	T <sub>p</sub>	1	T	TSBD	--	--	Hotel echo after long delay.
3	T <sub>2</sub>	1	T	TSBD	--	--	Hotel echo after long delay. Sharper -- less blast.
4	T <sub>p</sub>	2	T	TSBD -- all reverb to left.	--		Hotel echo (as in 2,3).
5	T <sub>2</sub>	2	T	TSBD	--	--	Single, thinner blast, smaller.
6	K	2	T	TSBD (or in front).	--	--	Crack before blast.
7	T <sub>p</sub>	--	T	TSBD diffuse.	--	--	Blasting.
8	T <sub>2</sub>	3	T	TSBD	--	--	Cracker.

A-17

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## A.2 (Cont.)

Shot No.	Origin	Target	Forced Choice Response	Apparent Source Description	Secondary Choice	Reverberations	Loudness
9	K	3	K	Knoll - big blast - booming, broad image where shooter was.	--	--	--
10	K <sub>p</sub>	3	K	Knoll - small source precise location firecracker.	--	--	--
11	T <sub>p</sub>	1	T	TSBD	--	--	Like 6.
12	T <sub>2</sub>	1	T	TSBD	--	--	More cracking than 10
13	T <sub>p</sub>	2	T	TSBD	--	--	Big blast - lots of reverb for 2 sec.
14	T <sub>2</sub>	2	T	TSBD	--	--	Reverb in front, little cracks.
15	K	2	T	TSBD or in front.	--	--	Big blast - diffuse.
16	T <sub>p</sub>	3	T	TSBD, more definite.	--	--	Hollow blast, more local to 6th floor.
17	T <sub>2</sub>	3	T	TSBD	--	--	Sharp

81-A

A.2 (Cont.)

Shot No.	Origin	Target	Forced Choice Response	Apparent Source Description	Secondary Choice	Reverberations	Loudness
18	K	3	K	Knoll, big blast.	--	--	Hollow, diffuse.
[We are across from the fence (we moved).]							
19	T <sub>p</sub>	4	K	Knoll and TSBD.	--	--	Crack, then blast - crack is above Knoll.
20	T <sub>p</sub>	4	K	Knoll and TSBD.	--	--	Same as 19.
21	T <sub>2</sub>	4	K	Knoll, big blast.	--	--	From right in front of us.
22	K	4	T	Knoll and TSBD	--	--	Crack then blast, similar to 19, less blast than 19.
23	T <sub>p</sub>	4	T	Knoll and TSBD.	--	--	Like 22.
24	T <sub>2</sub>	4	T	TSBD	--	--	Sharp crack from 6th floor.
25	K	4	K	Knoll	--	--	Like 19.

A-19