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An Examination of Factors Influencing Eyewitness Testimonies: Effects of Aggressive Questioning on Human Memory

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Abstract

The purpose of this study was to determine how aggressive questioning could affect human memory. Eyewitness identification is one of the leading causes for innocent victims to be imprisoned for crimes they have not committed. However, aggressive questioning may play a key role in what the eyewitness identifies. In the current study, two groups of college students viewed a videotape of a scene from the movie "Boys and Girls". One group of students were asked details about what they viewed by an aggressive, hostile interviewer. The other group was asked details about what they viewed by an understanding, calm interviewer. The results demonstrated that there was a difference between the two groups of eyewitnesses. Group Calm did better than Group Aggressive therefore; the current results suggest that aggressive questioning does influence the memory of an eyewitness.

An Examination of Factors Influencing Eyewitness Testimonies: Effects of Aggressive Questioning on Human Memory

Eyewitness identification is one of the leading causes of innocent victims being convicted for a crime. Some causes of these mistakes include the age (Poole & White, 1993) and stress (Peters, 1988) of the eyewitness. Event factors may also cause errors, such as exposure time to the event (Loftus, Schooler, Boone, & Kline, 1987), the violence of the event (Loftus & Burns, 1982) and misleading post-event information (Loftus, 1975). In addition, memories may be affected by pattern separation (Koutstaal & Schater, 1997) and difficulties with retrieving memories (McCelland, McNaughton, & O'Reilly, 1995). The way eyewitnesses are questioned with positive reinforcement (Wells & Bradfield, 1999) can create over confidence and mistakes in identifying the suspects (Luus & Wells, 1994) that may contribute to misidentification.

Age can play a key role in identifying individuals due to the fact that young children tend to be more susceptible to misleading information. If exposed to repeated questioning, they tend to be less accurate in their responses. Memon and Vartoukian (1996) suggested that children tend to believe that repeated questioning means that their first answer is incorrect, therefore, they are inclined to change their answers. In a study by Poole and White (1993), both children and adults witnessed one individual interacting with a group of people and another individual just walking by the group. The children and adults were asked questions about it immediately following the event and then

retested two years later. The results showed that the adults remembered the event more accurately than the children. However, these results are not surprising since adults' brains are more developed than children's.

Memory is also affected by pattern separation, which stems from difficulty in remembering the event that has occurred. In a study done by Koutstaal and Schacter (1997), participants were shown pictures of different items from various categories such as cars, footwear, computers, and food. These pictures were then mixed with unrelated pictures of items not belonging to any previous category. After a delay of three days, a test was administered to determine the recognition of the various objects. The results showed a high rate of false recognition for similar items within categories, thus showing poor memory for specific details of pictures. Therefore, if the words were similar in different categories, the similar words were remembered from all of the categories instead of one category. For example, if an eyewitness sees a man wearing a brown, yellow, and blue shirt with brown shoes and a brown hat, the witness may remember the brown in the shirt but may forget about the yellow and blue. This is one example of how individuals may confuse details. By using selective details or categories instead of particular details which may lead to misidentification. Therefore, recalling an event lies not only in remembering the overall event, but also in the way details of the event are encoded in memory. Associations with past experiences and stimuli can also alter memories during retrieval. The retrieval of the memory may become difficult due to

the stimulus and the event not being associated with each other in memory. When the stimulus and the event cannot be related in memory, such as "a weapon was in the robber's hand"; the retrieval of the memory might become difficult.

Another factor that influences eyewitness reports is how the information is retrieved from memory. Retrieving information is one of the pressures when dealing with human memory. Retrieval of past experiences involves a process of pattern completion (McCelland, McNaughton, & O'Reilly, 1995), in which a number of past experiences are recalled into the memory of the individual. A prime example of this phenomenon is false recognition. For example, subjects who are given a group of words based upon a particular theme, such as drowsy, bed, tired, pillow, rest and other associated words, will tend to report seeing the word "sleep" during the test. More than 70% of participants claimed to have seen the theme word when it did not actually exist in the study (Schacter, 1998), which shows that the cognitive processes can fill in for what is really not there. This can also occur during an event where eyewitnesses see a crime occur. For example, eyewitnesses may overhear other witnesses giving details of the events and incorporate them into their memories (Schacter, 1998), which is one reason why eyewitnesses should be questioned alone.

The attention of the eyewitness is another factor that has received extensive examination. Details of a situation may be forgotten or may not have been initially perceived due to the eyewitnesses' lack of attention to details of the situation or event.

The witness may become focused on the violence of the situation on irrelevant objects. For example, mental shock is associated with disrupting essential memory processing that is necessary for the encoding of information storage (Schacter, Norman, & Koutstaal, 1998). For example, if an eyewitness sees a weapon pointed in his or her face and becomes fixated on the object, he or she may not be able to identify the criminal's face, body size, or clothing (Gruneberg & Morris, 1992).

Another factor leading to misidentification is the presentation of post-event information. Loftus (1975) demonstrated this effect, of incorporating false information into the memory, resulting in an inaccurate report. In a fast moving film viewed by college students, a white sports car was shown driving down a country road. Immediately after viewing the video, the subjects were asked a series of questions designed to determine the effects that misleading information might have, such as, the presence of a barn. Subjects were asked questions suggesting the presence of a barn in the video although no barn was present. Two examples of the questions are: "How fast was the white sports car going while traveling along the country road?" and "How fast was the white sports car going when it passed the barn while traveling along the country road?" The latter question is considered a misleading post-event question or a presupposed suggestion. Later, all of the participants were asked whether they saw a barn. The misleading question produced a greater tendency for subjects to say that they had viewed a barn on the road. A barn was reported as seen by more than 17 percent with the presupposed suggestion but by only 3 percent with no presupposed suggestion (Loftus,

1975). Misleading post-event questions affect eyewitnesses' testimonies because they may add non-existing factors into the memory of the eyewitness.

Another experiment by Loftus and Palmer (1974) also demonstrated an alteration of human memory with the use of a filmed automobile accident. The subjects were presented a film of a car crash and then asked questions about what they had seen. These questions involved a change in the describing verb to elicit the speed of the vehicles. Examples of the questions are; "About how fast were the cars going when they smashed into each other" or " About how fast were the cars going when they bumped into each other". After a week had passed, another test was administered to all of the subjects to examine any alterations in their memory. The subjects given the verb "smashed" tend to answer, "Yes" to the question, "Did you see any broken glass?" even though no broken glass existed in the videotape. Results showed that over 70% of the participants answered the question correctly regarding seeing broken glass (Loftus & Palmer, 1974).

The exposure time for the event may also affect the accuracy of the eyewitness to identify the criminal. Loftus, Schooler, Boone, and Kline (1987) demonstrated that the greater the length of exposure time to the target stimulus, the more accurate were the reports for identifying a robber. A 30-second video of a bank robbery was shown to half of the subjects and a 60-second video was shown to the other half. The accuracy rate in identifying the robber was lower following the short video. It is suggested that the longer the eyewitness views the situation the more accurate the reports will be when identifying a criminal. Loftus et al. (1987) suggested that the accuracy following longer exposure

was due to the individuals having a longer time to make an identification during the video.

Stress is yet another factor that plays a role in eyewitness memory. Stress is pressure or tension, whether its physical or mental, created by an internal or external stimulus. According to Yerkes and Dodson (1908), the effects of stress depend on the task and are related to performance in a curvilinear fashion. A low level of stress tends to produce poor performance. Moderate levels of stress facilitate good performance while excessive levels of stress also tend to result in poor performance. The stress levels of individuals may also affect the performance on memory tasks. In a study by Peters (1988), subjects at a health clinic met two individuals, a nurse who gave half the subjects an injection, and a researcher who spoke to the other half of the subjects. Both met with the subjects for the same amount of time. One week later, the subjects were asked to identify both individuals from an array of photos. Peter's found that more subjects correctly identified the researcher. It was suggested that the stress produced by the nurse giving the injection resulted in poorer recall of that nurse. However, Yuille and Cutshall (1986) have reported conflicting results. They found that individuals under more stress, as defined as proximity to an actual shooting, demonstrated a higher level of accuracy in recalling the event. Therefore, the shock of the experience of being close to the event may have altered the effects on the recall of details. Subjects perform differently under stress, therefore, this factor needs to be taken into consideration when interviewing eyewitnesses.

A factor related to the level of stress of the eyewitness is the level of violence of the event. More violent events tend to be recalled less accurately. In a study by Loftus and Burns (1982), one group of subjects watched a non-violent version of a robbery while the other group was shown a violent version. In the violent version, a young boy was shot in the face as the robbers were getting away. The subjects who viewed the non-violent tape had a better recall rate than the other group that viewed the violent version of the same crime. This may be due to a mental shock that is associated with the violence of the event.

Memory can also be altered due to the eyewitness having personal opinions about the particular items. Eyewitness reports given by individuals can be influenced by their perception of the situation and by their personal likes and dislikes. Hanstorf and Cantril (1954) showed fans of two opposing football teams a video and then asked them to identify inappropriate behaviors that are penalties. Each group identified more penalties in the rival team than for their own team. Therefore, it would be suggested that eyewitnesses might judge items based on their own personal preferences.

Memory confidence may also be affected by using misleading information during the questioning of eyewitnesses. A study using information from the court case Iowa v. Chidester (1995) was examined in an experiment investigating memory confidence. In this case a man was shown entering a Target department store on a security camera. The man had just murdered the security guard minutes before entering the store, however,

participants in the study were not given this information. They were only told that they would be asked questions regarding the tape. Finally, after viewing the video, each participant was asked to identify the murderer on a photo-spread sheet that did not contain a photo of the man in the video. The actual photo-spread sheet from the court case was used in the experiment except the murderer was removed. The participants had a high rate of misidentification due to the fact that the criminal was missing from the spreadsheet and they were not informed of the possible absence of the individual (Malpass & Devine, 1981). Wells and Bradfield (1997) conducted a similar type of experiment and found that every participant made an inaccurate identification instead of determining that the individual was not shown on the spreadsheet. Therefore, eyewitnesses might be encouraged to identify someone, whether correctly or incorrectly, because of pressures to solve the crime.

Surprisingly police officers make incredible errors in identifying suspects. In a recent study (Park, Lee, & Lee, 1996), police cadets and college students experienced overconfidence as the major source for misidentification. One group of police officers and two groups of college students were asked to view an educational video on the remarkable abilities of newborn babies. In the video, a man with a knife threatened a Shopkeeper. This was shown unexpectedly during the viewing of the newborn babies. After watching the videotape, the subjects were tested in regards to the robbery. The results suggest that the eyewitnesses were paying more attention to the educational aspect of the video instead of the surprising robbery.

Overconfidence in eyewitness identification can punish innocent individuals. Investigators can be a contributor to overzealousness of eyewitness testimonies by providing positive reinforcement during questioning. For example, Luus and Well (1994) reported that if after an eyewitness makes a false identification from a photo-spread sheet, then an investigator tells them a co-witness has identified the same individual, their confidence level will increase. This rapid increase in confidence level can also occur when an eyewitness is repeatedly asked the same questions (Shaw & McClure, 1996). The questions that are presented during the investigation may also affect the reports from the eyewitnesses. Some questions used by Pool and White (1993) that may increase confidence levels are, "What did he look like?" and, "Can you tell me anything else about how he looked?"

Police officers often put pressure on eyewitnesses in order to solve a crime. Positive reinforcement, after identification, increases confidence in the eyewitness. In a study conducted by Wells and Bradfield (1999), all participants viewed the same videotape of the security guard being murdered and were then asked to identify the criminal. The participants were then divided into three groups and each group was asked different questions. The first group was given positive reinforcement after their identification, thus not being questioned. The second group was asked a question about their certainty before feedback, such as "At the time that you identified the person in the photos, how sure were you that the person you identified was the gunman in the video?" The third group was asked a question about their view of the crime before feedback, such

as, " How well could you see the gunman?" After the questions, each individual was to rate themselves on a scale of 1 to 7 in regards to their level of confidence of their identification. The results suggested that the group given positive reinforcement had a higher level of confidence than either of the other two groups. There are two possible explanations for this finding. One is that positive reinforcement increases confidence, a second is that being asked about the response reduces their confidence.

The purpose of interviewing eyewitnesses is to collect specific evidence that can be used for future legal proceedings (Kebbell & Wagstaff, 1997). According to Gudjonsson (1992) there are four basic objectives in interviewing eyewitnesses. First, the officer must discover that a crime has been committed. Second, the officer must determine whether the eyewitnesses are telling the truth and are reliable. Third, if a crime was committed, the officer must find evidence to identify the individual responsible. Fourth, the officer must produce evidence to convict the individual responsible for the crime.

The way police officers are trained to conduct an interview of an eyewitness can greatly influence the results of both the investigation and the judicial process. In a study by Kebbell and Milne (1998), 358 police officers were given a Likert-type questionnaire to fill out. The questionnaire contained two parts; the first part contained general demographic information such as age, gender, rank, length of service and operational roles and the second part contained questions regarding their experience with eyewitnesses. The results revealed that most police officers never, or rarely, had enough

time to complete what they believed to be "good" interviews. The study also showed that the limitations on police officers' time to conduct interviews were very short. During training, police officers are given adequate time to practice their interview techniques, however, time is of the essence at the scene of a crime. Another important factor involved in the interview process is the style of questioning. As an example, consider the research by Loftus (1975) in the context of a police investigation. According to Fisher (1995), law enforcement officers tend to use an interrogative style of questioning due to inadequate interviewing training. This is a major problem when questioning eyewitnesses to a crime.

The current study examined the effect of another factor regarding the interview process. The study examined whether aggressive questioning of the eyewitness can alter their accuracy and confidence in reporting what they saw. One group of college students was interviewed by an aggressive, hostile interviewer after viewing a short videotape. Another group was interviewed by a calm, understanding interviewer after viewing the same short videotape. All participants were then given a questionnaire to assess their memory of the video. It was expected that the group being interviewed in an aggressive manner would have less accurate recall than those interviewed in a calm manner.

Method

Subjects

Subjects consisted of 15 college students. There were 5 males and 10 females with an age range from 19 years to 22 years. Each subject volunteered to participate in

the experiment. College majors included psychology, sociology, art, education, and business. The students did not receive extra credit for participating in the study.

Materials

The instruments used to conduct this study were a 21-inch color television, a segment of videotape from the movie, "Boys and Girls," and a videocassette recorder. The study took place in a relaxed atmosphere where the participants sat in chairs that were placed close enough to see the television. The study also included two separate forms of test questions (see Appendices 1 and 2). Interviewers were given instructions on how to conduct each interview (see Appendix 3). The test questions were examined to determine how many subjects in each group answered each question correctly (see Appendix 4).

Procedure

Prior to the start of the experiment, all interviewers were given instructions and training on how to conduct each interview. Then, participants were divided into two groups, one group containing 8 individuals, that was Group Calm, and the other containing 7 individuals, that was Group Aggressive. All participants viewed a 90-second videotape of a scene from a recent movie, "Boys and Girls". The scene depicted the two main characters in a laundry/coffee shop. The scene contained many objects that could have been identified by the eyewitnesses.

Immediately after viewing the videotape, Group Calm was asked questions about what they had viewed by a calm, understanding, caring person. Each person was

questioned separately. The interviewer nodded and gave understanding replies such as "Yes, I understand that is what you saw" or "Okay, so let me get this right, you saw a man not wearing a hat?" The interviewer also used a calm tone of voice with little alteration in pitch.

After viewing the videotape, the participants in Group Aggressive were asked questions about what they had viewed by a hostile, aggressive person. The interviewer paced back and forth using a loud tone of voice and ignoring personal space. The interviewer would reply to the witnesses with "Uh, you saw what?" or "Well, how many people have tattoos, can't you tell me more?" After completing the questioning procedure, the tape was reviewed with the participants and the correct answers were given to each participant.

Results

Before the results were analyzed, the interviewers were asked about the effectiveness of their questioning. Interviewer Calm believed that being understanding and calm with eyewitnesses would help the witnesses to be more accurate in their responses. Interviewer Aggressive believed that witnesses would be less accurate due to becoming nervous during the interview process.

Examination of the test scores revealed that the mean for Group Calm was 9.625 correct responses and the mean for Group Aggressive was 6.857 correct responses. The tables below represent the number of questions that each individual got correct.

Table 1	Number of Questions Correctly Answered
Participant	Group Calm
One	8
Two	12
Three	8
Four	10
Five	10
Six	11
Seven	11
Eight	7
Total	9.625

Table 2	Number of Questions Correctly Answered
Participant	Group Aggressive
One	8
Two	8
Three	7
Four	6
Five	7
Six	6
Seven	6
Total	6.857

To analyze the accuracy of the eyewitnesses, an independent sample t-test was used. The results showed that there was a statistically significant difference between Group Calm and Group Aggressive, $t(13) = 3.729$, $p = .003$. Therefore, the results suggest that Group Aggressive was less accurate than Group Calm in regards to their recall of the video.

Discussion

The hypothesis that Group Aggressive would do worse on the memory task was supported. According to the results, aggressive questioning of the eyewitnesses did affect their memory. The aggressive questioning may have been responsible for the effect in many different ways.

One possible reason for why Group Aggressive performed more poorly on the memory task is due to their level of stress. In accordance with Yerkes and Dodson (1908), the participants in Group Aggressive may have experienced excessive stress by being questioned in an aggressive manner by the interviewer. This may be an aspect that police officers may need to consider during training. Police officers that use an aggressive questioning style may produce adverse affects on the eyewitness' memory performance. Aggressive questioning could be an important factor if the eyewitnesses have just seen a crime scene. Consistent with this view, aggressive questioning following a violent situation could result in even poorer memory for the event by the eyewitness. Thus, not only would the violent situation lead to increased levels of stress, but the

aggressive questioning would exacerbate the level of stress, further effecting the memory recall of the eyewitness.

Another possible explanation for why Group Aggressive performed more poorly could have been the result of positively reinforcing Group Calm. Giving positive reinforcement during questioning can alter the responses given by the eyewitnesses (Well & Bradfield, 1997). Group Calm was given positive reinforcement by a calm and understanding interviewer whereas, Group Aggressive was pressured and given negative feedback after each question. Therefore, police officers should examine the feedback that they use while questioning eyewitnesses. Since positive reinforcement can produce better results than negative reinforcement, police officers should be calm and positive during questioning to improve confidence levels and possibly memory.

The present study did suggest a connection between misidentification and aggressive questioning that might influence the responses of eyewitnesses. Misidentification of criminals should be taken very seriously in order to decrease the conviction rate of innocent people. During police officer's training, the officers should be involved with many different aspects of how to question eyewitnesses. Aggressive questioning should be used during training to show the effect it has on the eyewitnesses' memory of the event or crime. Calming procedures should be used with the eyewitness to help produce a balanced level of stress, which will produce better results from the eyewitness. This current study suggests that aggressive questioning can alter the

responses of eyewitnesses. Therefore, using a calm interviewing style may help eyewitnesses recall information more accurately.

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Appendix 1

Questionnaire for Group Calm

1.Where did the scene take place? **(That is a good answer.)**

2. What was the female main character's name? **(Just think about for a minute.)**

3. What color was the male's hair in the scene? **(Okay, that's good.)**

4. About how many people were in the scene? **(Just estimate.)**

5. How many cups were on the table in front of the main characters? **(Yes, I understand that is what you saw.)**

6. About how long did the female talk? **(Just give an estimate.)**

7. How long did the female main character talk? **(Think about what she was saying.)**

8. How many tattoos were in the scene and describe them? **(That's a fine answer.)**

9. Was the male main character wearing a hat? **(Okay, so let me get this right, you saw a man not wearing a hat.)**

10. About how many people were sitting at the bar? **(Just an estimate.)**

11. Did you see a telephone in the scene near the main characters? **(Clear your mind and then think about the answer.)**

12. What color was the female main characters eye color? **(Think about it for a minute.)**

13. Was there any signs or posters on the door? **(Think about the color of the door.)**

14.Was the female main character wearing jeans? **(It's okay if you don't know.)**

15. Did you see any cleaning supplies? **(Think about where the scene takes place.)**

16. How many people did you see wearing pink? **(Include the main character.)**

17. How many people did you see wearing glasses? **(That's a good answer.)**

18. What was the female main character talk about during the scene? **(We all deal with this issue.)**

Appendix 2

Questionnaire for Group Aggressive

1.Where did the scene take place? **(Hurry and answer.)**

2. What was the female main character's name? **(You should listen for someone's name, its important.)**

3. What color was the male's hair in the scene? **(Okay, there are only four colors it could be.)**

4. About how many people were in the scene? **(Just estimate!)**

5. How many cups were on the table in front of the main characters? **(Just think about how many people you saw and answer.)**

6. About how long did the female talk? **(Give an estimate!)**

7. How long did the female main character talk? **(Think about what she was saying.)**

8. How many tattoos were in the scene and describe them? **(Well, how many people have tattoos, can't you tell me more.)**

9. Was the male main character wearing a hat? **(Most males do.)**

10. About how many people were sitting at the bar? **(Just an estimate!)**

11. Did you see a telephone in the scene near the main characters? **(Don't take all day!)**

12. What color was the female main characters eye color? **(You've been thinking for over a minute, come on!)**

13. Was there any signs or posters on the door? **(What about the door?)**

14.Was the female main character wearing jeans? **(Don't you know?)**

15. Did you see any cleaning supplies? **(It is only a yes or no.)**

16. How many people did you see wearing pink? **(Don't forget the main character.)**

17. How many people did you see wearing glasses? **(Uh, you saw what?)**

18. What was the female main character talk about during the scene? **(We all deal with this issue, so you should know this.)**

Appendix 3

Instructions for Interviewing

After viewing the video a group of subjects will be asked a list of questions provided to the interviewers. During the interview it is very important to follow the question exactly, do not alter the question. Remember to express what is in the bold print beside each question. The calm understanding interviewer will use a soft tone with no alterations in pitch. Make lots of eye contact and nod to the answers. The hostile aggressive interviewer must use a loud voice and pace back-and-forth in the room. This interviewer should roll their eyes at the witness and rely the bold part of the questions quickly the witnesses' responses.

Appendix 4

This table presents the number of the questions and how many from each group the question correct and incorrect.

Question Number	Group	Calm	Group	Aggressive
	Correct	Incorrect	Correct	Incorrect
1	8	0	7	0
2	0	8	1	6
3	8	0	7	0
4	5	3	6	1
5	0	8	1	6
6	1	7	4	3
7	2	6	1	6
8	7	1	3	4
9	6	2	4	3
10	6	2	3	4
11	5	3	5	2
12	5	3	4	3
13	6	2	5	2
14	3	5	2	5
15	3	5	1	6
16	2	6	2	5
17	5	3	4	3
18	8	0	7	0

Irony on the Mountain: From the Battle of Blair Mountain to Mountaintop Removal.

McNair Scholar: Roger Basham
Mentor: George Towers

Paper Content:

Roger L. Basham and George Towers, Department of Geography, Concord College, Athens, WV 24712-1000. E-mail: georget@concord.edu. Irony on the Mountain: From the Battle of Blair Mountain to Mountaintop Removal.

Our research deals with the ironic reversal of labor politics evidenced in two demonstrations on Blair Mountain, West Virginia: the 1921 Battle of Blair Mountain and the 1999 march against mountaintop removal. In 1921, coal miners marching to organize West Virginia's southern coalfields met mine guards at Blair Mountain in a pitched battle. Turned back by federal troops, the miners retreated and the coalfields remained non-union until the 1930s. Today, Blair Mountain is at the center of the controversy over mountaintop removal, a radically destructive form of strip mining. A federal court's ruling against West Virginia's approval practices has cancelled state-issued mountaintop removal permits, including those for Blair Mountain. In August 1999, environmentalists and labor sympathizers marched on Blair Mountain to commemorate the 1921 Battle and protest mountaintop removal. They were confronted, however, by an angry group of unemployed union miners who had been laid off following the court's decision.

Labor's demonstration of allegiance to industry interests on Blair Mountain is sadly ironic in the face of its 1921 defeat on the same ground. Investigation of the political symbology of parades informs us that demonstrations, such as those on Blair Mountain, keep the past present and remind us of our heritage. The marches on Blair Mountain symbolize southern West Virginians' tortured path towards economic independence and demonstrate the mining industry's power in determining the state's political culture.

Keyword: parades, labor politics, West Virginia

Introduction

Parades, as defined by Sallie Marston, "are complex phenomena that have been identified variously as cultural, political, social, recreational, and economic in their nature and outward display" (Marston, 1989). For centuries parades have been used to celebrate freedom, persuade political factions, and show solidarity within a community. The idea that a parade can evoke solidarity and promote political awareness is evident when considering the academic interpretation of parade literature.

The extensive literature on parades deal with various scenarios such as labor and working class issues. Authors like David Roediger, Philip Foner, Eugene Plawiuk and Ted Watts have written about and revere the working class laborers for their fight against the power of the industrial establishment. These interpretations create a romanticized view of the struggle for liberation.

Purpose

The purpose of this paper is to show that the academic views pertaining to parades are not always accurate. Any example of this divergence is the Irony in the 1999 re-enactment march on Blair Mountain in Logan West Virginia. The re-enactment march deviates from the romanticized and idealized interpretation of similar events such as Labor Day and May Day celebrations

To establish a sound model for the interpretation of the Blair Mountain re-enactment proceedings, the historical significance of Labor Day and May Day need to be identified. We will first look at the Labor Day celebration and the significance it has on

the 1999 re-enactment, followed by the May Day celebrations and the part they play in the comparison.

Labor Day Literature

Labor Day is a workingman's holiday. The origins of Labor Day stem from labor unrest in the 1880's. The first parade was on Tuesday, September 5, 1882 in New York City. The parades were really protest rallies for the adoption of the 8-hour workday organized by the New York City Central Labor Union (CLU) in conjunction with the Knights of Labor (Watts, 1983, Foner, 1969).

In the 1890's, the American Federation of Labor (AFL) replaced the Knights of Labor. The AFL became the dominant force in labor organization. As the AFL grew and the Labor protests continued, tensions began to mount in Pullman, Illinois. George Pullman, president of the railroad sleeping car company, founded the town in 1880. Pullman designed and built the town as a utopian workers' community shielded from the moral and political influences of nearby Chicago (Montgomery, 1995, Watts, 1983).

The town was strictly organized: row houses for the assembly workers; Victorians for the managers; and a luxurious hotel where Pullman himself lived and where visiting customers, suppliers, and salesman would lodge while in town. All of the residents of the town worked for the Pullman Company, paychecks came from a Pullman bank, and rent was deducted from their weekly paychecks. For more than a decade the town and company was run successfully (PBS, 1996)

In 1893, the Pullman Company was caught in the nationwide economic depression. Pullman was forced to lay off hundreds of employees. Those who remained endured wage cuts, while rent in Pullman remained constant. Take-home paychecks plummeted.

So the employees walked out, demanding lower rent and higher pay (PBS 1996, Roediger 1986, Watts 1983)

The American Railway Union (ARU), led by Eugene V. Debs, came to the cause of the striking workers, and railroad workers across the nation boycotted trains carrying Pullman cars. As the strike grew in magnitude, rioting, and burning of railroad cars ensued, and the strike became a national issue. President Grover Cleveland declared the strike a federal crime and deployed 12,000 troops to break the strike. Violence erupted, and two men were killed when U.S. deputy marshals fired on protesters in Kensington, near Chicago. The strike was doomed (Watts, 1983, Wildmoon, 1995).

On August 3, 1894, the strike was declared over. Debs went to prison, his ARU was disbanded, and Pullman employees signed a pledge that they would never again unionize. Industrial workers' unions were effectively stamped out and remained so until the Great Depression.

Nevertheless, a need to appease the nations' laborers became apparent. Protestors were criticizing President Cleveland's actions during the Pullman Strike. Cleveland knew that with an election coming up he would have to do something. A bill was rushed through legislature just six days after the end of the Pullman strike. When the bill arrived on President Cleveland's desk he seized the opportunity to gain the peoples trust and in 1894 Labor Day was signed into law as a national Holiday (Wildmoon, 1995).

Academic interpretation of Labor Day literature

According to David Roediger, "Labor Day is misunderstood and is one of this countries most enduring holidays". If it were not for Labor unions fighting so hard for workers rights, the 40-hour workweek would not be a realization; neither would health

insurance or pension plans. Labor Day stands not for a rushed appeasement of the workers but as a true victory for laborers and labor unions (Roediger, 1986). Philip Foner views Labor Day as the first push toward union establishment on a global scale. His belief in the sincerity of the actions of the striking workers against there oppressors shows the solidarity of the workingman and the power of the union. Foner believes that Labor Day is now nothing more than a civic event compared to protest rallies and demonstrations of the first participants (Foner, 1969).

Views such as the ones expressed by Foner and Roediger add a romantic zeal to Labor Day and the establishment of a holiday for the workingman. Although Foner believes that Labor Day is has turned into nothing more than a civic event, the idea that the struggling laborers can rise above their problems and unite in solidarity still remains.

May Day literature

The counterpart to the Labor Day issue is the socialist May Day parades. May Day celebrations originated in Pagan Europe. It was a festive holy day celebrating the first spring planting. The ancient Celts and Saxons celebrated May 1st as Beltane or the day of fire. Like Labor Day, the modern celebration of May Day as a working class holiday came form the struggle for the eight-hour workday in 1886.

On May 1, 1886 strikes began in support of the eight-hour workday. In Chicago, the Knights of Labor held protests in support of this action. Police killed six people during a protest in Chicago. The following day during demonstrations in Haymarket Sqtiare a bomb was thrown into the crowd, killing eight police officers. The police arrested eight of the protesters who claimed to have thrown the bomb. These eight men would become known as the Chicago Eight (Thomas, 1998).

The trial that ensued was to be one of the most publicized trials of the 19th century. The eight men tried were not only tried for the bombing but also for being agitators and sympathizers for the working class people. Four men, Albert Parsons, August Spies, George Engle and Adolph Fischer were executed by the state of Illinois (Plawiuk, 1996).

In 1889 the International Working Men's Association (the First International) declared May 1st an international working class holiday. In commemoration of the Haymarket Martyrs, the Pioneer Aid and Support Association erected a monument commemorating the fallen workers in 1893. Red flags were used as a symbol of the blood of working class martyrs in their battle for workers rights (Thomas, 1998, Plawiuk, 1996).

Soon after May Day was declared an international holiday by the International Working Man's Association, celebration of the new holiday began around the world (Roediger, 1986, Thomas, 1998). In 1947, the Red Scare and the anti-Communist Cold War put an end to May Day in the United States. May Day was renamed "Loyalty Day" and was said to be designed as a weapon against leftist labor tendencies, and specifically the American Communist Party, by encouraging citizens to reaffirm their commitment to the State (Scaack, 1889, Thomas, 1998).

Academic interpretation of May Day literature

Eugene Plawiuk author of "The Origins and Traditions of May Day" and Micheal Thomas author of "May Day in the USA: A Forgotten History" believe that May Day celebrations area a true socialist victory over labor struggles. While Plawiuk looks at the victory of the workers and the establishment of a day of recognition for workers rights,

Thomas views May Day as a day forgotten by the United States and believes that May Day should be celebrated the world over (Plawiuk 1996, Thomas 1998).

The interpretation of the literature on Labor Day and May Day celebrations depict a push for unity and worker rights that creates the issuance of a day for the Laborers. The idea that if you work hard enough, you will get the credit and appreciation deserved, epitomized the American laborer and along with strong labor organizers, catapulted the liberation of the working class to the forefront in the United States as well as globally.

While this may be true, what does it say about the labor issues in West Virginia and the re-enactment march on Blair Mountain and the struggle for workers rights and the establishment of the union? To answer this question the historic events leading to the re-enactment march on Blair Mountain need to be discussed including: a brief history of coal mining in West Virginia, labor struggles with the development of the union and the creation of a new mining technique known as Mountaintop Removal .

Brief history of Mining in West Virginia

West Virginia is a labyrinth of broken valley and mountain ridges that are as complicated as they are majestic. These mountains are rich in minerals, especially coal. Minable seams of bituminous coal lie beneath seventeen thousand square miles of West Virginia. In 1870 there were only eighty-five small operations producing about 608,000 tons of coal valued at approximately $1 million. By 1880 production had reached 1,968,000 tons, valued at $2 million (Rice, 1993).

As the mining industry grew, West Virginians soon became part of an economic system controlled by the coal industry just as was the case with the Pullman workers in

Illinois. Miners worked in company mines with company tools. Their rent and living items came from company stores and taken from their pay. The stores charged over-inflated prices because the script the mines paid the miners was only good at company stores (Corbin, 1976). Therefore, even when wages were increased, the company store would just raise prices on their goods.

In addition to the economic conditions, safety in the mines was a great concern. Very quickly West Virginia fell far behind other major coal-producing states in regulating mining conditions. Between 1890 and 1912, West Virginia had a higher death rate than any other state. One historian has suggested that during World War I, a U.S. soldier had a better chance of surviving in battle than did a West Virginian working in the mine (Corbin, 1976).

Mine company control and Union Development

In 1890, the United Mine Workers of America (UMWA) was formed in Columbus, Ohio. In the first years of development the UMWA was successful in organizing miners in Pennsylvania, Ohio, Indiana, and Illinois. Organizational attempts in West Virginia were unsuccessful in 1892, 1894, 1895, and 1897. The poor conditions in West Virginia continued and it wasn't until 1902 that the UMWA finally achieved recognition in the Kanawha-New River coalfield (Cole, 1982, Jordan, 1977).

Shortly after union development in 1902 coal operators began to plan an attack on the new union forces. In 1903, coal operators formed the Kanawha County Coal Operators Association (KCCOA). The coal operators' believed the union movement wanted the push towards socialism in the coalfields of southern West Virginia.

The first thing the Association did was hire detectives from the Baldwin-Felts Detective Agency in Bluefield as mine guards to harass union organizers. This harassment discouraged organizers from working in southern West Virginia. The union lost control of the Kanawha-New River Coalfield in 1912 due to the efforts of the KCCOA and the Baldwin-Felts detectives (Corbin, 1990).

As tensions mounted, the harassment grew violent and deadly. Miners at Paint Creek and Cabin Creek went on strike to try and increase wages. Once again, as the strike began, operators brought in mine guards from Baldwin-Felts Detective Agency. This time their job was to evict striking miners from the company homes. (Corbin,1990).

During this time, the intimidation the mine guards were using caught the attention of national labor leaders including Mary Harris "Mother Jones", who was already a major force in the American Labor movement. As a leader for the development of the UMWA in West Virginia, Mother Jones began to speak out against mine operators and politicians alike and as tensions grew even stronger the UMWA began to supply weapons and ammunition to the striking miners. This was the beginning of the "mine wars" which lasted from 1919 to 1921 (Corbin, 1981, Scholten, 1979).

The Mine Wars

The mine wars developed out of the need for unification of miners against the coal operators and to establish a union to protect the rights of those miners. The battles began a few years after the strike of 1912-13 in the Paint and Cabin Creek area. The entry of the US into World War I sparked a boom in the mining business and wages for miners' rose. However, the end of the war resulted in a recession, resulting in the lay off of miners and an attempt to reduce wages to pre-war levels (Mooney, 1967).

By 1919, the largest non-unionized coal region in the Eastern United States consisted of Logan and Mingo Counties. The UMWA targeted this area of southwestern West Virginia as its top priority (Sullivan, 1991). The coal operators' association in southern West Virginia had strengthened their system for combating labor.

The coal companies realized that the union was beginning to grow strong so the Logan Coal Operators Association paid Logan County Sheriff Don Chafin to keep union organizers out of the area. Chafin and his deputies harassed, beat, and arrested those suspected of participation in labor meetings. He hired a small army of additional deputies, paid directly by the association. By the summer of 1919, rumors reached Charleston pertaining to the actions of Chafin's men.

On September 4th, 1919 armed miners began gathering at Marmet for a march on Logan County. By the 5th, their numbers had grown to 5,000 men. Governor John J. Cornwell and Frank Keeney dissuaded most of the miners from marching in exchange for a governmental investigation into the alleged abuses. Cornwell appointed a commission whose findings did not support the union (Mooney, 1967).

A few months later, operators lowered wages in the southern coalfields. To compound the problems, the U.S. Coal Commission granted a wage increase to union miners, which excluded those in southwestern West Virginia. Mingo County miners went on strike in the spring of 1920 and called for the assistance from the District 17 office in Charleston (Lee, 1969).

Fred Mooney and Bill Blizzard, one of the leaders of the 1912-13 strike, spoke to around 3,000 miners at Matewan. Over the next two weeks, about half of the 3,000 miners joined the union. On May 19th, 1921 twelve Baldwin-Felts detectives arrived in

Matewan. Families of the miners who joined the union were evicted from their company-owned homes. The town's chief of police, Sid Hatfield, encouraged Matewan residents to arm themselves. Gunfire erupted when Albert and Lee Felts attempted to arrest Hatfield. Seven detectives and four townspeople lay dead, including the mayor C.C. Testerman (Sullivan, 1991).

These actions sparked the beginning of the mine wars in southern West Virginia. After the Matewan Massacre and the acquittal of Sid Hatfield for the deaths of the seven detectives, Hatfeild once again was being put on trial for a shooting in a Mohawk Coal camp in McDowell County. As he walked up the steps of the McDowell County courthouse in Welch, Baldwin-Felts detectives gunned down Hatfield. Miners gathered in Charleston to protest the killing. UMWA leaders Frank Keeney and Bill Blizzard urged the miners to fight. Over the next two weeks, Keeney traveled around the state, calling for a March on Logan (Savage, 1990).

On August 20th, 1921 miners began assembling at Marmet and on the 24th began their march towards Logan. The miners wore red bandanas, which earned them the nickname, "red necks." In Logan County, Don Chafin mobilized an army of deputies, store clerks, state police, and mine guards. Meanwhile, after a request by Governor Morgan for federal troops, President Harding dispatched World War I hero Henry Bandholtz to Charleston to survey the situation.

Bandholtz and the Governor met with Keeney and Mooney and explained that if they continued, the miners and the UMWA leaders could be charged with treason. That afternoon, Keeney met a majority of the miners at a ball field in Madison and instructed them to turn back. Some ended the march; however, two factors led many to continue.

First, special trains promised by Keeney to transport the miners back to Kanawha County were late in arriving. Second, the state police raided a group of miners in Sharples, killing two. In response to these events, many miners began marching towards Sharples, just across the Logan County line (Mooney, 1967).

A natural barrier, Blair Mountain, located south of Sharples protected the town of Logan. Forces under the command of Colonel William Eubank of the National Guard took positions on the crest of Blair Mountain as the miners assembled in the town of Blair, near the bottom of the mountain. Baptist minister John E. Wilburn organized a small-armed company to support the miners (Sullivan, 1991).

Wilburn's men shot and killed three deputies and over the next three days, intense fighting ensued as Eubank's troops brought in planes to drop bombs on the miners. On September 1st, President Harding finally sent federal troops in from Fort Thomas, Kentucky. Air squadrons from Langley Field near Washington, D.C. were sent in but most of the aircraft didn't make it, crashing in places ranging from Nicholas County to Raleigh County. The military air power played no important part in the battle.

On the 3rd, the first federal troops arrived at Jeffery, Sharples, Blair, and Logan. The miners did not want to fight with federal troops so most surrendered. Some continued fighting until the 4th, at which time virtually all surrendered or returned to their homes. At least twelve miners and four men from Eubank's army were killed along with thousands of wounded miners and soldiers. Those who surrendered were put on trains and sent home and those suspected of being leaders were to be held responsible for the actions of all the miners. The grand jury handed down 1,217 indictments, including 325 for murder and 24 for treason against the state (Savage, 1990).

The defeat of the miners at Blair Mountain temporarily ended the UMWA's organizing efforts in the southern coalfields. UMWA membership in the state, by 1924, had dropped by about one-half of its totals in 1921. The National Recovery Act of 1933 protected the rights of unions and allowed for the rapid organization of the southern coalfields (Laurie, 1991, Jordan, 1977).

Development of Mountaintop Removal

The coal industry in West Virginia is deeply entrenched within the political, social and economic development of the state. From the beginning, mining practices have been looked upon as a form of oppression. Critics claim coal operators purposefully undermined future economic and social development within the state. The re-enactment march on Blair Mountain symbolizes the struggle for recognition of the workingman and the protest against new domination.

A recent development along these lines indicating coal industry dominance is Mountaintop Removal Mining. Mountaintop removal in West Virginia began on a small scale in the 60's, and became the dominant coal mining technique in the 1990's. It involves the extraction of coal that lies in horizontal seams between layers of rock. To extract it, mountain rock must be blasted away to reveal the coal seams below. These blasts are 10 to 100 times more powerful than that of the 1995 Oklahoma City bombings (Wilson, 2000, Loeb 1997).

After blasting the rock, the "overburden" that is left must be cleared. "Big John", a gigantic shovel that reaches 20 stories tall, loads the overburden into huge dump trucks, the trucks then dump the overburden into nearby valleys. On one mining site, 10 square miles of mountain, up to 600 feet below the surface, can be removed. There can be as

many as 12 valley fills on one mining site. These fills average 1,000 feet wide and one mile long (Wilson, 2000)

Once the overburdened is cleared away, the coal has to be brought up from inside the mountain. Large draglines, costing 100 million dollars, are run 24 hours a day, removing millions of tons of coal per year. Coal trucks have to haul 20 loads an hour (24 hours a day in some cases) just to keep up with the draglines (Loeb 1997).

Economic Viability of Mountaintop Removal

Mountaintop Removal is economically viable because West Virginia coal is some of the most valued coal in the country. It burns hot and in a clean manner with low sulfur emissions; making it perfect for companies needing clean burning fuel to supply the growing demand for electricity. This need for clean fuel stems from the 1990 signing of The Clean Air Act.

The Clean Air Act was passed because of the need to regulate the amount of pollution emitted into the atmosphere. The installation of scrubbers inside smokestacks and exhaust ports is expensive so companies use clean burning fuel to cut down on the replacement and cleaning of the scrubbers. With the push for cleaner fuels, mountaintop removal expanded to meet the need (Loeb 1997).

More coal is being mined than ever before. The State of West Virginia produced 169,206,834 million tons of coal in 1999. Advancements in technology have allowed for the creation of big machinery, like large draglines and huge earth moving equipment, which has made mountaintop removal possible. On the down side, these new advancements in technology have brought high unemployment. The advancements in

technology that allowed for the creation of mountaintop removal sharply decreased the need for manpower (Ward, 1998).

Environmental Effects of Mountaintop removal

The radical environmental effects of Mountaintop removal are permitted because mining regulations are not enforced. The 1977 Surface Mining Control and Reclamation Act, the nation's most important mining law, silently left mountaintop removal unregulated. The Surface Mining Control and Reclamation Act was designed to prevent contamination of water and damage to houses from blasting done by strip mining, which then only skimmed small swaths off the sides of mountains. The 1977 statute also required that mined land be restored to its previous use and contours, but waivers were often given to mountaintop removal operations (Loeb 1997, Wilson, 2000).

When the Surface Mining Control and Reclamation Act was written, some West Virginians, led by then Rep. Ken Hechler, tried to prohibit mountaintop removal because it would destroy the natural contours of the land. Their effort failed, and an amendment allowing it, if granted a variance, was added by Sen. Wendell Ford of Kentucky. Senator Ford was an advocate for the expansion of mountaintop removal because of the growing mountaintop mining in the state of Kentucky (Loeb 1997, Ward, 1998).

Mountaintop Removal causes serious environmental risks to the coalfield community. The people who live in and around these mine sites are forced to endure dangerous and possibly deadly hardships. Some small towns have practically disappeared because of the dangers involved in mountaintop removal mining.

Flying debris and smothering coal dust blanket the landscape of these little towns.

Slowly these towns' die and left in the wake are growing rubble piles of refuge from burnt and ravaged homes. Joblessness, environmental risks and destruction along the need to recognize Blair Mountain as an historical landmark have pushed local residence to take action against this technological onslaught.

Blair Mountain re-enactment

James Weekley (a retired miner) from Pigeons Roost in Blair, West Virginia created the Blair Mountain Historical Organization (BMHO) to honor the miners who fought for their right during the Battle of Blair Mountain. The organization was created to help establish Blair Mountain as a historical site, almost 80 years after the battle took place. Weekley also petitioned the courts to put an injunction on illegal mountaintop removal mining (Ward, 1998, Weekley, 2000).

In August of 1999 Weekley and his BMHO organized a re-enactment march of the Battle on Blair Mountain. The participants, including West Virginia Secretary of State Ken Heckler began their march in Marmet, just as the original miners did almost 80 years ago. During the march the participants were bombarded with eggs and rocks along with slanderous comments. The perpetrators were pro mining politicians such as Logon County Commissioner Art Kirkindoll and out of work miners (Seiler, 2001, Weekley, 2000).

Results of re-enactment

The protests were against a re-enactment honoring the attempts to unionize the southern coalfields and the blood and life lost during the Battle of Blair Mountain. The miners protested the re-enactment because they believed that it was these actions by James Weekley that put them out of work, the ironic twist is that these miners were laid

off union workers and were fighting against a re-enactment that honored union organization.

The ideal scenario would be to join in praise of fellow miners that had fought and gave their lives for what they believed in. Instead the opposite occurred, unity and solidarity spawned hatred and contempt for the very people that were being honored. The re-enactment march on Blair Mountain sought to express the need for recognition and acceptance for the plight of the workingman, like the Labor Day And May Day struggles of some one hundred years before. Historically, events such as these have been revered as a unifying entity among like-minded people. Labor Day and May Day both were successful in conveying their intended purposes but for Blair Mountain the end result was not as success

Conclusion and Final Thoughts

The history behind the union struggle in the southern coalfields mirror that of the situations in other parts of the country and around the world. Labor Day and May Day were successful in bringing attention to the need to recognize the hard work of American and International workers. The comparison between the outcomes of these events and the re-enactment march on Blair Mountain are strikingly different, posing the idea that academic interpretations of similar events such as Labor Day and May Day do not hold true in every situation.

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A Study of the Relationship Between the Brain's Perception and Processing and the Teaching of Musical Concepts

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RESEARCH MATERIAL AND DATA

Educators are looking for ways to improve the actual amount of learning that takes place with students. Psychological, methodological, sociological, and many other variables have been analyzed to discover a more effective way of teaching more to students. One approach identifies different types of learners and constructs lessons for each type of learner. By doing this, the program hopes to increase the amount of learning for each student. This type of program has been created for use in the regular classroom. The findings from the research on learner types, however, can be applied to areas of teaching music. In the field of music, there is a need for a common, identifiable curriculum that can be comparative nationwide for public schools. Most schools tend to teach primarily the same musical concepts mostly because of time constraints and because the concept is easily teachable. As a result, teaching a musical concept rarely occurs because of its musical importance to the students. If one could apply the findings from the education fields about types of learners to the field of music education, all music concepts would have opportunity to be taught, rather than only those concepts that are most conveniently taught. With the understanding of how information is processed, and how it is to be taught, any musical concept should be able to be taught successfully. The amount of learning that takes place among music students can be increased, by correlating various teaching methods, with the way the brain perceives and processes a musical concept. This would, in turn, allow stronger criteria in the choosing of a music curriculum.

It is evident through the study of schools and teaching methods that schools are designed for one basic type of learner, the analytical learner. The rise of civilization, both culturally and socially, is directly correlated to our ability to be rational, theoretical, and abstract. Therefore, teaching students to learn analytically is an important issue, but not the only issue (4MAT I, 13). It has been proven that 70% of all learners are not analytical learner's (51), yet almost 100% of schools demand this type of learning process. The reasons are obvious. Time constraints, accessibility to methods of teaching all learners, and the level of difficulty to reach all processes are most often the contributing factors for teachers demanding this type of learning. The benefits of developing the very best student's possible, however, are priceless and educators should produce 100% of the best rather than the sparse 30%. In a regular classroom the activities requiring students to take part are always the first to be cut and for what seems to be

preposterous reasons such as the students are too noisy. By allowing students to be an active part of the learning process and enabling them to add their own ideas yields a more complete student and thus a more enlightened society.

David Kolb has discovered "Strong correlation's between the learning styles of students and their rating of the teaching style of the teacher who has influenced them most." (84). If educators are to reach all students, then teaching all types of learners is vital, thus giving students the opportunity to become and develop their true learning styles in a comfortable way. There is no reason that any student should be deprived of this right simply because the way they process information does not conform to a regular classroom. Teaching to all students is not an option, but an essential component to the classroom.

Educational researchers have consistently come up with the same findings about different types of learners. While the learner types all are given different titles, the researchers acquire the same findings. Carl Jung referred to the learners as feelers, thinkers, sensors, and intuitors; while David Merill calls them amiable, analytic, driver, and expressive. Barbara Fischer, Anthony Gregorc and Alexis Lotus all have the same conclusion that there are four basic types of learners. By studying all the information and combined research one can get a more in-depth view of the different types of learners.

Learning begins with the two-fold operation of perception and processing. Perception comes in two forms: abstract and concrete. Concrete learners are sensor/feeler learners and abstract learners are thinkers. Schools value the latter approach. The two types of processors are the watchers and the doers. In this category the watchers are favored. When perception is combined with processing, the four basic types of learners emerge. They are as follows: diverger, converger, assimilator, and accomodator (25). Divergers absorb information concretely and process reflectively. Assimilators absorb information abstractly through experience and then process reflectively. Convergers experience abstractly and process actively. Accommodators experience concretely and process actively.

Diverger-sensor/feeler watcher	concrete learner
Converger-thinker doer	abstract learner

Assimilator-thinker watcher	abstract learner
Accommodator- sensor/feeler doer	concrete learner

The combination of perception and processing is learning style (25).

The four types of learners are drawn from two basic brain functions. The two hemispheres of the brain, right and left, control the different types of perception and processing. Dr. Roger Sperry has determined how various learner's process information differently using medical procedure in which he cuts the connection between the two hemispheres of the brain, the corpus callosum (69). His findings clearly show a linear processing in the left hemisphere, while the right hemisphere uses a global processing that perceives, absorbs, and processes data while it is in the process of changing. This information shows that there is a verbal side and a non-verbal side of thinking. The left hemisphere goes through a systematic process until a conclusion is reached. The right hemisphere, however, will reach conclusions as the information is processed and will change accordingly.

Musical concepts are controlled in different parts of the brain. Both hemispheres control some concepts while others are directly related to only one type of processing. Musical image processing is basically dependent upon the right hemisphere and musical information processing is dominantly a left brain function (Music, Mind, and Brain; 154). For example, the understanding of note values would basically be a left hemisphere process, while the understanding of timbre would predominantly be a right hemisphere process. The findings of musical concepts in different parts of the brain are as follows:

Musical Rhythm

Musical rhythm is a deeply seated function of both hemispheres. There is a debate over whether or not this is primarily a right or left hemisphere function.

Musical Competence

pitch discrimination-right hemisphere
timbre-right hemisphere
melodic line-right hemisphere
single musical notes-right hemisphere

The greater the musical sophistication, the more the left hemisphere is brought into play.

Musical Memory

Musical memory is the interaction of sequences of pitch, melodies, timbre, and harmonies, overall phrase interval and scale. It uses both hemispheres.

Musical Attention

Musical attention is dependent upon the competence to process musical information. Competence is dependent upon the organization of musical memory.

(21)

Singing and musical performance requires integration and cooperation between the hemispheres. (156)

The program discussed hopes that educators will teach in all four learning styles in order for all students to develop musical concepts within each learning style. This is accomplished by effectively teaching for all types of learners, thus giving all students the chance to excel 25% of the time, as well as, develop musical abilities that will continue to develop throughout their lifetime. In order to indicate what learner type an individual is, there must be definite characteristics of each type of learner. The following chart shows characteristics derived from a compilation of theories that describe the four divisions of learners.

1) **"DIVERGERS"**

-seek meaning
-need to be involved personally
-learn by listening and sharing ideas
-absorb reality
-perceive information concretely and process it reflectively
-interested in people and culture
-divergent thinkers who believe in their own experience
-excel in viewing concrete situations from many perspectives
-model themselves on those they respect
-function through social interaction
-strength: innovation and imagination...idea people
-goals: self-involvement in important issues
-favorite questions: "why or why not?"
-careers: counseling, personnel, humanities, and organizational development

2) **"ASSIMILATORS"**

-seek facts
-need to know what the experts think
-learn by thinking through ideasY.they form reality

-perceive information abstractly and process it reflectively
-less interested in people than ideas and concepts; they critique information
-data collectors
-thorough and industrious, they re-examine facts if situations perplex them
-enjoy traditional schools
-schools are designed for these learners
-function by adapting to the experts
-strength: creating concepts and models
-goals: self-satisfaction and intellectual recognition
-favorite question: "what?"
-careers: basic sciences, math, research, and planning departments

3) **"CONVERGERS"**

-seek usability
-need to know how things work
-learn by testing theories in ways that seem sensible...they edit reality
-perceive information abstractly and process it actively
-use factual data to build designed concepts
-need hands-on experiences
-enjoy solving problems
-resent being given answers
-restrict judgment to concrete things
-have limited tolerance for "fuzzy" ideas
-need to know how things they are ask to do will help in "real life"
-function through inferences drawn from sensory experience
-strength: practical application of ideas
-favorite question: "how does this work?"
-careers: engineering, physical sciences, nursing technicians

4) **"ACCOMODATORS"**

-seek hidden possibilities
-need to know what can be done with things
-learn by trial and error, self discovery
-enrich reality
-perceive information concretely and process it actively
-adaptable to change and relish it
-like variety and excel in situations calling for flexibility
-tend to take risks
-at ease with people, but often seen as pushy
-often reach accurate conclusions in the absence of logical justification
-function: by acting and testing experience
-strength: action, carrying out plans
-goals: to make things happen, to bring action to concepts
-careers: marketing, sales, action-oriented, managerial jobs

(4MAT I, 30)

If a student perceives in one learning area and processes in another, then the process of teaching according to the way in which a student learns must incorporate the way a concept is perceived as well as, how it is processed. The following is a description of the way each hemisphere of the brain operates. The

understanding of how each hemisphere operates will allow a way to determine the way of perception and processing for each musical concept.

Description of Right Brain

visual, spatial, three-dimensional thinking

sensory information is handled by recognizing faces and sorting through pieces of visual scene

imaginative, creative, intuitive, non-verbal, visuospatial

simultaneous, analogical, gestalt, synthetic

Description of Left Brain

language, speech, problem solving

compelled to analyze and group sensations in ways that allow for finer-grained decisions

interprets behavior and emotional states of themselves and others, and makes inferences about how the world works

analytical, objective, concrete

verbal, sequential, temporal, digital, logical, rational

THE APPLICATION

The intent of this project is to take the aforementioned information and apply it in a new way. The hypothesis combines the research found about learner types and research found about the brain hemispheres and their processes of musical concepts to state a new possibility. That is to attempt to find if there is a new teaching strategy that will incorporate these two studies to make a new study. The hypothesis is that musical concepts can be more effectively understood if they are taught in a manner that corresponds with the hemisphere used, and the way that hemisphere organizes the information. For example a left brain concept such as music vocabulary will be more easily understood if it is taught using verbal and analytical tactics for explanation. The opposite is true for a right brain concept.

The following is a description of the method that will be used to determine if the hypothesis is correct.

Method

1. Observe four teachers as they teach three specified musical concepts to their class and identify the method used for each concept.

2. Test students to find how much the students know about each musical concept.

3. Compare the student's knowledge of the concept with the method the teacher chose to use.

Several considerations have been examined to determine specifically which musical concepts should be of greater priority to music educators. A few basic musical concepts that are clearly defined were used for the intent of this project. The selected musical concepts have been taken from the National Content Standards for Music, as determined at the National Standards for Arts Education Conference in 1994. The guidelines are as follows:

**Singing (alone and with others), a varied repertoire of music*
**Performing on instruments (alone and with others), a varied repertoire of music*
**Improvising melodies, variations and accompaniments*
**Composing and arranging music within specified guidelines*
**Reading and notating music*
**Listening, analyzing and describing music*
**Evaluating music and music performances/Understanding relationships between music, the other arts and disciplines outside the arts*
**Understanding music in relation to history and culture*

(Bley, 17)

This experiment will include three, sixth-grade classrooms. This age level has been chosen because sixth grade students have a basic knowledge of the fundamentals to be tested, but are still in the process of developing an understanding of the concepts. The test for the students will cover concepts of scale, key signatures, and meter. The requirements for the performance standards include these three basic functions. The observation of the teachers will identify the teaching methods of these concepts.

The amount of learning that takes place by students is affected by the method a teacher chooses to use due to the various learning styles in a classroom. If the majority of students perceive and process specific musical concepts in a particular hemisphere of the brain, then an identification of where the specific concepts are processed would enable a more effective teaching process to occur. This should demonstrate that if each teacher has taught in a manner that correlates with how the information is processed, then the amount of learning should be higher for the students. When the teacher does not match the concept with the hemisphere of the brain that processes it, the amount of learning will be lower for the students.

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HUMAN SUBJECTS APPROVAL

Human Subjects Committee

Crystal Belcher

PROJECT INFORMATION:

This information must be typed. Please number paragraphs according to the number of items appropriate for your project. If an item is not applicable please put NA (for not applicable).

Items 1-7 (Required to be completed for all projects):

1. Provide a brief project description. In a few words, describe the objectives, methods and procedures of the project. The emphasis should be on the human subject involvement in the project. Discussion of theoretical or statistical aspects of the project should be avoided. If a questionnaire, and/or testing instrument is to be used describe how it will be administered, by whom, and its source. If interviews are to be conducted, describe the nature of the interview and how responses will be recorded.

The objective of this project is to determine what methods of teaching is most effecient by observing the different ways teachers use to convey specific musical concepts to students and then determining which method was more effective by testing the students. This will be done by having teachers to teach particular concepts to students, observing the method they use, and giving the students a music comprehension test over these concepts. It will also include a short interview with the teacher.

2. Number and the relevant characteristics of subjects.

The number of students used will be determined by the number of students in each classroom. Approximately four elementary, fifth grade music students will be used.

classes of

3. Describe how subjects will be selected for participation in this project and any fees, extra credit, or other items they will receive for participation if appropriate.

Subjects will be determined by who is in the elementary classroom chosen, and whether or not they are a beginner student. The classrooms will be chosen by the teacher & principals agreement. Only students who have signed the permission slip and need as their parents will participate

4. Status and qualifications of research assistants, if any.

none

5. Source of funding for project.

McNair Scholarship

6. Expected starting and completion dates for project. (Note that project cannot begin until approval has been received from HSRB. Projects are given approval for a maximum of one year, if they continue past that point they must again receive HSRB approval).

Starting date: 12/97 Completion date: 5/98

7. Attach copies of all questionnaires, testing instruments, OT interview protocol; also any cover letters or instructions to subjects.

Items 8-11 are required for Categories II and III

8. Specify steps to be taken to guard the anonymity of subjects and/or the confidentiality of their responses. Indicate what personal identifying indicators will be kept on subjects. Specify procedures for storage and ultimate disposal of personal information.

Students results will be presented in a quantity, not as individuals and if individual data is presented no names will be attached to the information. After complete data is taken down, names on the tests will be replaced with numbers and the personal information done away with.

9. Specify how subjects will be informed of the following basic elements of informed consent (these would be included in the written or read statement of consent and so labeled):

(A) A statement that the study involves research.

Students, parents and teachers will be informed by letter of consent.

(B) Explanation of the purpose of the research and the expected duration of the subjects involvement (e.g. how long will it take to complete the survey).

Informed by letter of consent.

(C) Description of the procedures to be followed, and identification of any procedures which are experimental.

1 Description of any benefits to the subject or to others which may be reasonably expected from the research.

2 Description of any reasonably foreseeable risks and discomforts to the subject.

3 Statement describing the extent, if any, to which confidentiality of records identifying the subject will be maintained.

4 For research involving more than minimal risk, an explanations as to whether any medical treatments are available if injury occurs, and if so what they consist of, or where further information may be obtained.

In formed by letter of consent.

5 Explanation of whom to contact for answers to pertinent questions about the research and research subjectsÆ rights, and whom to contact in the event of a research-related injury to the subject. See appendix

Informed by letter of consent.

6 Statement that participation is voluntary, refusal to participate will involve no penalty or loss of benefits to which the See appendix subject is otherwise entitled.

Informed by letter of consent.

7 Subject may discontinue participation at any time without penalty or loss of benefits to which the subject is otherwise entitled.

Informed by letter of consent.

The HSRB must be provided a written description of these elements of informed consent to be presented to the subjects. If the research cannot practicably be completed without this requirement being waived or altered, please say so here, and include a debriefing procedure.

10 If the subjects are to be drawn from an institution or organization (e.g. hospital, social service agency, prison, school, etc.) Which has the responsibility for the subjects, then a copy of that assurance or, if not available, documentation of permission form that institution must be submitted to the Board before final approval can be given.

Principal & Teachers permission will be ascertained before study is conducted

11 If the subjects will come into contact with any mechanical, electrical, or electronic or any other equipment, Form 1A and a complete description of equipment must be written in order for the safety of the equipment to be checked.

LETTER OF CONSENT

Crystal M. Belcher
P.O. Box 132
Freeman, WV 24724
(304) 248-8082 or
384-5855

Statement of Informed Consent

This form describes a research study being conducted with young people and their learning of music. The purpose of the research is to learn more about the best way to teach specific musical concepts to students of an early age. The project director is Crystal M. Belcher at Concord College. If you consent to this study you will be allowing your child to take part in my observation and a short music comprehension test. The study will be done over a period of several weeks.

There are no know risks involved in this study. If you have any questions or concerns about your child, and/or if your child has any questions about the study, feel free to contact me and discuss them. All of the participant's test will be presented publicly in an anonymous manner.

The possible benefits of participation in this study are that the information gathered will allow music educators a greater ability to teach to future students with greater efficiency.

Your child's participation in this study is completely voluntary. The participation in or lack of participation will not affect your contact with any legal authorities, helping professionals, or other service agencies. You are free to change your mind or stop participation in the study at any time and there will be no penalty.

You are being asked to decide whether or not to allow your child to participate in this study. If you wish to allow your child to participate, and you agree with the statement below, please sign in the space provided.

I,_____, have read (or had read to me) and understand the information provided in this form and agree to participate as a subject in this project.

_____ _____
(Signature of subject) Date

_____ _____
(Signature of students guardian) Date

Appendix

Crystal M. Belcher
P.O. Box 132
Freeman, WV 24724

Dear Band Director or Music Teacher:

My Name is Crystal M. Belcher and I am a student at Concord College involved in the McNair Scholarship program. I am a music education major and am currently doing a research project in which I am studying the teaching/learning processes involved in teaching music to young children. I am writing this letter to ask for your permission to observe your classroom while your students are being taught several musical concepts. I would also like to ask that you would teach these specific musical concepts on specific days I will be observing your class. I will be more than willing to cooperate with your schedule. I would also like to interview you at some point during these observations to account for any misinterpretation of facts.

Enclosed in the last page of this letter is a description of my project and how I would like to incorporate your class into my study. I appreciate your time and hope that you will consider my proposal. If you have any questions, please do not hesitate to contact me. Please let me know if you are willing to participate by calling me any evening at either of the following phone numbers. (304) 384-5855 or (304) 248-8082. Please inform me of your decision by 12/1/97. Thanks again.

Sincerely,

Crystal M. Belcher

Crystal M. Belcher
P.O. Box 132
Freeman, WV 24724

Dear Principal or Administrator,

My Name is Crystal M. Belcher and I am a student at Concord College involved in the McNair Scholarship program. I am a music education major and am currently doing a research project in which I am studying the teaching/learning processes involved in teaching music to young children. I am writing this letter to ask for your permission to observe a music or band classroom at your school while your students are being taught several musical concepts. I will also be asking the teachers to teach specific musical concepts on the days I will be observing the class. I will be more than willing to cooperate with their schedule of course and provide any needed information. The project has been approved by the human subjects committee and has not involved risks to the students.

Enclosed in the last page of this letter is a description of my project and how I would like to incorporate the class into my study. I appreciate your time and hope that you will consider my proposal. If you have any questions, please do not hesitate to contact me. If you would like to review the information and then get in touch with me please contact me at the following numbers: (304) 384-5855 or (304) 248-8082. Please inform me of your decision as soon as possible in order for the projects completion. Thanks again.

Sincerely,

Crystal M. Belcher

PROJECT DESCRIPTION

Project Description

The intent of this project is to incorporate the study of how student's perception and processing of information can aid in the teaching of musical concepts. It will attempt to show that because children learn specific types of information in a particular part of the brain, the way the information is presented to them will affect how much learning takes place.

The concepts I would like you to cover are as follows:

**Time to Cover*	*Concept to Cover*
*1 period	1) The concept of scale
*1 period	2) The concept of rhythm
*1 period	3) The concept of meter

Please make sure the information covered is new material, or on a new level for the class period in which I will be observing. This will help prevent any misinterpretation of variables from school to school.

While observing the class I will ascertain what teaching method is used as to determine what part of the students brain is likely to be most active.

At the end of the total observation, students will be given a short music test covering these musical concepts. One class period will be needed to administer the test, although the test may not take up an entire classroom period. It is preferable that the entire observation be grouped together in a few weeks rather than spaced out over a period of time.

MUSIC COMPREHENSION TEST

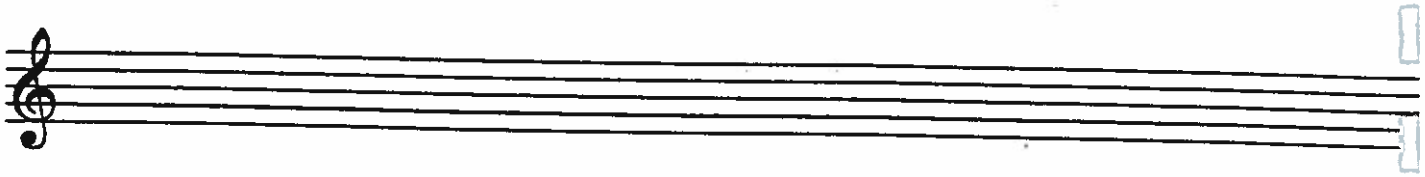
MUSIC COMPREHENSION TEST

Name_____

Part I

Scales

I. Write out the Bb major concert scale.



II. How many notes are in a major scale?

_____

III. How many flats are in a Bb major concert scale?

_____

Part 2

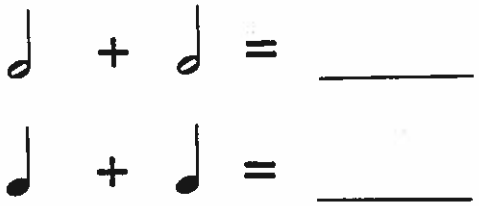
Rhythm

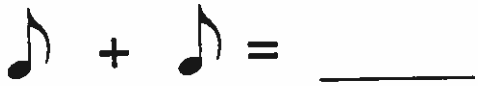
Answer the following questions.

1. Match the following notes in column 1 to the corresponding values in column 2.

1) whole note	a) two
2) half note	b) four
3) quarter note	c) one-half
4) eighth note	d) one

2. Write the needed note in the blank.





3) Write the counting below the following line of music.

Listen to the following music examples and answer the questions.

Example #1

1. How many quarter notes did you hear?

Example #2

Did the speed of this song stay the same?

Part III

Meter

Please answer the following questions.

1) What is the time signature of this example?

2) What does the top number of the time signature mean?

3) What does the bottom number mean?

Add barlines to the following piece of music.

Study of Canine Colonization and Transmission of *Bordetella pertussis*

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Study of Canine Colonization and Transmission of *Bordetella pertussis*

Abstract - The bacterial pathogen *Bordetella pertussis* is the causative agent of the respiratory disease in humans known as pertussis or whooping cough (1,15). Pertussis affects adults and children of all ages, though the most serious infections generally occur in unvaccinated infants under one year of age. Non-primate mammals may be able to carry *B. pertussis* and be infective, without showing clinical illness. In order to test this hypothesis, two groups of puppies were experimentally infected with *B. pertussis*. Group one was designed to test the ability of infected pups to transmit *B. pertussis* to uninfected littermates. Group two pups were all infected with B. pertussis and euthanized at one week intervals to determine localization of the bacteria in the respiratory tract over the course of an infection. Bacterial presence was determined using nasopharyngeal swabbing, histopathology, and Polymerase Chain Reaction (PCR). The pups antibody response was measured using Enzyme Linked Immunosorbent Assay (ELISA). A few pups showed minor lesioning of the lungs, hyperplasia of the tonsilar lymphoid nodules, and lymphoid breakdown of tonsilar epithelium. Three group one uninfected pups were positive for *B. pertussis* DNA in their tonsils, while the infected pups had all cleared to levels undetectable by PCR by the fourth week. Only the infected pups in group one showed significant antibody response at the third and fourth week. Three of seven group two pups showed *B. pertussis* DNA in their tonsils and five showed *B. pertussis* DNA in their lungs. The only significant antibody response in group two was in the pup that carried for four weeks. Although canines are capable of harboring *B. pertussis*, the ability of pups to transmit the bacteria to young children appears to be extremely limited.

The bacterial pathogen *Bordetella pertussis* is the causative agent of the respiratory disease in humans known as pertussis or whooping cough (1,15). Pertussis affects adults and children of all ages, though the most serious infections generally occur in unvaccinated infants under one year of age. The mortality rate is highest among children between three months and twelve months of age (12,14). The disease is somewhat less severe in older children and adults, possibly due to previous exposures or vaccination (14). The dynamics of clinical pertussis are a seven to ten day period of incubation followed by the catarrhal stage, which resembles many common viral respiratory infections. The catarrhal stage is followed by the paroxysmal stage in which the characteristic coughing occurs. Paroxysmal coughing fits are often followed by vomiting and the characteristic "whoop" sound (1,15). Recent findings suggest that many cases of clinical pertussis patients do not exhibit the whooping sound (12). Such cases are termed "atypical" pertussis (12,14). With the growing epidemic of human immunodeficiency virus (HIV), many cases of severe pertussis are now occurring in AIDS patients (13).

Although the distribution of pertussis is worldwide, it is more common in underdeveloped nations where effective vaccination programs have yet to be implemented. Such vaccination programs in the United States have thus far been successful in managing the pertussis problem (4). According to one source, approximately 89.5% of children ages 19 to 35 months were vaccinated in 1995 (3). The standard DTP vaccine currently used is reported to have some rare but severe side effects attributed to the pertussis portion of the vaccine, including febrile convulsions and hypotonic-hyporesponsive episodes (4). These reported side effects have prompted several countries to cease administering the vaccine, resulting in severe outbreaks of pertussis among the unvaccinated population (17). Current efforts are being made to market a viable, acellular vaccine alternative (4). Prospects for the acellular vaccine include filamentous hemagglutinin (FHA), pertussigen (LPF), pertactin, and two different agglutinogens (4).

All organisms in the genus *Bordetella* are extracellular pathogens that infect the ciliated epithelium of mammalian or avian upper respiratory tract and lungs (1,15). *Bordetella pertussis* causes whooping cough primarily in primates, although some clinical manifestations have been witnessed in other respiratory models (7,15). Parapertussis, a much milder respiratory infection than whooping cough, is caused by *Bordetella parapertussis* (1,15). The mild symptoms of parapertussis result in its being reported very infrequently. Serological analyses suggest parapertussis infection is quite common (15). Another *Bordetella* infection caused by *Bordetella bronchiseptica* is known to infect many domestic animals, such as dogs, cats, guinea pigs, and rabbits. In dogs, a *B. bronchiseptica* infection causes a disease known as Kennel Cough. The same organism causes a condition in pigs called atrophic rhinitis. There have also been cases reported in which *B. bronchiseptica* has infected man (15). Symptoms resemble those of whooping cough, although mortality is low (15). *Bordetella bronchiseptica*, *B. pertussis*, and *B. parapertussis* are all very closely related at the species level, with genetic analysis suggesting that they are strains of the same species rather than proper species themselves (1,15). Experiments have been performed in which one species of *Bordetella* was converted to another in the laboratory (10,15).

B. pertussis and *B. bronchiseptica* can be distinguished from one another by several simple biochemical tests. *B. bronchiseptica* rapidly turns urea broth red (within four hours) while *B. pertussis* has no urease activity (1,15). *B. bronchiseptica* utilizes citrate as its sole carbon source, an ability which *B. pertussis* lacks (15). *B. pertussis* and *B. bronchiseptica* are also differentiated between by special selective media. For example, *B. bronchiseptica* will grow on MacConkey's agar while *B. pertussis* will not (15). *B. bronchiseptica* also grows much more rapidly than the notoriously slow growing *B. pertussis*, which may take as long as five days to produce significant colonies on Bordet-Gengou agar (15). Colonial morphology is also distinctive for each species, with *B. bronchiseptica* having large, shiny, caramel colored colonies with undulate margins and *B.*

pertussis colonies being much smaller, round, and pale cream colored with smooth margins. Identification by differential media, colonial morphology, or biochemical testing is only possible when live bacteria can be cultured from the subject. This is not the case in many of the subclinical atypical pertussis cases seen in older children and adults in which culturing by nasopharyngeal swabbing is negative despite verification of infection by ELISA or PCR (9).

Since *B. bronchiseptica* is a common pathogen in canines, it is not hard to imagine an organism as closely related as *B. pertussis* could also colonize in the respiratory systems of dogs. This has been demonstrated to be the case, although the dogs rarely developed clinical symptoms (17). Several other non-primate respiratory models have been used to study pertussis, such as the chicken embryo and the mouse (2,6,7,13). Studies indicate the murine model to resemble pertussis infection in a manner which is analogous to infection in man (16). Symptoms seem to be a function of infection dosage, with large doses causing classical signs and death, and smaller doses resulting in the relatively asymptomatic atypical pertussis.

Older children and adult humans who have developed partial immunity, or whose immunity as a result of exposure or vaccination has waned below protective levels, may also develop atypical pertussis (18). Until recently, many cases of atypical pertussis either went unreported or were misdiagnosed due to the mild symptoms. With the advent of Enzyme-Linked Immunosorbent Assay (ELISA) technology it is now possible to rapidly diagnose atypical pertussis (18). This is important because recent studies have shown these atypical carriers can easily transmit pertussis to susceptible infants (12,14,18). Findings by Nelson and Mertsola suggest this sort of transmission is very common and that a significant number of cases of clinical pertussis in infants are the result of subclinical or atypical pertussis in adults or older siblings (12,14).

Dogs could develop a condition analogous to human atypical pertussis and potentially transmit this infection to other exposed dogs or to humans. Experiments

performed by Veit and Roop (1985) indicate upper respiratory colonization of *B. pertussis* can take place in canines and persist for up to four weeks, by which time the bacteria have been effectively cleared from the upper respiratory tract (17). The same preliminary study also suggested that transmission from inoculated animals to exposed animals can take place. The culturing of *B. pertussis* from suspect tissues is difficult and time consuming, requiring minimally one week. More rapid diagnostic techniques are required for effective diagnosis. This study used the bacterial agglutination method to determine antibody levels against *B. pertussis* in the exposed dogs systems (17,18). Results showed a considerable increase in antibody titer in the exposed dogs, an indicator of exposure. Recently, the polymerase chain reaction (PCR) has been developed as a diagnostic technique for the detection of *B. pertussis*. PCR is a more sensitive technique which allows for the detection of DNA from a single *B. pertussis* chromosome (9). A study by Lind-Brandberg found PCR to be superior to ELISA in both sensitivity and selectivity (9). Combination testing by PCR, ELISA, and nasal cultures could be a more effective diagnostic method for future experiments.

If puppies infected with pertussis are able to transmit the organisms to other pups which may come in contact with them, it is not unreasonable to conclude that perhaps interspecial transmission is possible from dog to man or vice versa. In his study on atypical human pertussis and its epidemiology, Nelson sites that a significant number of cases seem to arise from unknown origins and are not traceable to family members, other children, or other common transmission pathways (14). It would be interesting to note whether the families in which the unexplained cases occurred had any pets which may have been exposed to pertussis and transmitted it to the child through contact during play. Very little research has been done on the possible transmission of pertussis from domestic animal to human. Further studies would help generate a clearer understanding of the epidemiology of *B. pertussis*.

The pilot study done by H. P. Veit and R. M. Roop (1985) hinted at the possibility of transmission from an infected pup to another animal, but was performed on a sample size too small to be significant. Several other factors affect the validity of this study as well. The large number of organisms in the inoculum were not representative of actual dosages of the bacteria a dog is likely to encounter through contact with an infected individual. Also unrealistic was the double exposure two days apart (17). It is much more likely that a dog in the "natural state" would encounter *B. pertussis* in a much smaller dose and through a brief encounter with an infected individual. There also seems to have been a problem with the *B. pertussis* inoculum being contaminated with *B. bronchiseptica* in the second dosage (17). Assay techniques in this pilot study were limited to serum antibody titers, which do not differentiate between *B. pertussis* and *B. bronchiseptica*. The results of this study need to be confirmed using the newer techniques available to detect and differentiate minute the quantities of *Bordetella* one would expect in a sublethal case such as these. The second experiment of the study gives much more concrete evidence of transmission (17). In this study *B. pertussis* was cultured from lung samples taken at necropsy in one of the exposed dogs. All exposed dogs produced culture from nasopharyngeal swabs until the expected clearance time of four weeks, but yielded no *B. pertussis* from lung culture at necropsy. Again, more sensitive techniques, such as PCR, are now available which would be able to detect very minute bacterial presence in tissue samples.

Since the initial study by Veit and Roop (1985), assay techniques have become much more sensitive. Antigens for ELISA have become more refined and are now commercially available for more accurate standardization. It has become possible, through PCR, to detect minute amounts of bacterial DNA from a tissue culture or nasopharyngeal swab in an animal that otherwise appears healthy. The proposed study would facilitate greater understanding of the transmission of pertussis among domestic animals, specifically canines, and help to assess the manifestations of the disease in dogs over the

four week period prior to clearance. Further study is warranted to check the lock on the epidemiologic back door, to investigate whether transmission of pertussis from animal to man is a possibility.

It is the intent of this study to utilize the more sophisticated techniques currently available to assess the feasibility of interspecial transmission by observing transmission among littermates of a non-primate species, in this case puppies. The first experiment will focus on transmission of pertussis in a litter of pups in which roughly one third have been inoculated with *B. pertussis*. Infections will be detected by nasal swab culture, serum analysis, and PCR of several tissues harvested at necropsy. In addition, the pups will be monitored regularly for outward signs of disease. A second experiment will look for localization of *B. pertussis* in various tissues of the respiratory tract at one week intervals. These pups will also be screened for infections by nasal swab culture and serum analysis. The pups will be euthanized and necropsied at 1, 2, 3, and 4 weeks post inoculation, the pertinent tissues harvested and analyzed using PCR. Through these tests we hope to learn about host pathogen interaction in pertussis and also examine transmissibility between non-primate animals.

Materials and Methods

Two litters of puppies were obtained from the Montgomery County Animal Shelter in Christiansburg, Virginia. The pups were housed in the Infectious Disease Unit at the Virginia - Maryland Regional College of Veterinary Medicine, Center for Molecular Medicine and Infectious Diseases, Blacksburg, VA. Pups were provided *ad libidum* food and water, and their weight and temperature were recorded daily for one week, and once per week thereafter. All pups were subjected to a one week acclimation period. All dogs were dewormed and screened for *B. bronchiseptica* by nasal swab culture and serum analysis prior to testing. Nasal passages were swabbed with calcinate alginate swabs (Fisher Scientific) using a 1% solution of casamino acids (Sigma Chem. Co.) as transport media. Swabs were used to inoculate both Bordet - Gengou (Difco) and MacConkey's

agar (Difco) plates, which were incubated for 7 - 10 days at 37° C. All dogs were *B. bronchiseptica* negative by culture.

Group 1 - A litter of eight pups designated 9 - 16, consisted of five females and three males. Pups were estimated to be approximately five to six weeks of age. Following the acclimation period, three randomly chosen pups (9, 11, and 13) were challenged intranasally with an inoculum containing 5 X 10^6 cfu of *B. pertussis* per 0.5 ml suspended in Stainer-Scholte media (Gibco), with 0.5 ml delivered to each nostril (15,17). The remaining five pups received 0.5 ml of sterile Stainer-Scholte media per nostril. Inoculation day was considered day 1 for the study. Body weight, temperature, and rate of respiration were recorded daily for one week, and once per week thereafter (days 7, 14, 21, and 28). The pups nasal passages were swabbed using calcinate alginate swabs with a 1% solution of Casamino acids as transport media on days 1, 2, 4, 7, 14, 21, and 28. Swabs were cultured on both Bordet Gengou agar (15% sheep blood, 100 µg/ml cephalexin) and MacConkey's agar (1,15). Blood (approximately 1ml) was drawn once weekly beginning at day one (days 7, 14, 21, and 28) for serum analysis. Pups were monitored for outward clinical signs of disease such as nasal discharge, coughing, or dyspnea. At four weeks post inoculation, all animals were euthanized and necropsy was performed to look for internal signs of disease such as gross respiratory lesions. Samples of tonsil, trachea, lung, and spleen were taken for bacterial culture, PCR (polymerase chain reaction) assay, and histologic analysis. Samples for histologic analysis were stored in neutral buffered formalin at room temperature until processing.

Group 2 - Litter consisted of seven pups designated 17 - 23, consisting of four males and three females, and a bitch; which were housed separately from group 1 pups in the same facility. The pups were housed with the bitch, but separated by a pen and allowed to nurse *ad libidum*. All group 2 pups were challenged intranasally with an inoculum containing 5 X 10^6 cfu of *B. pertussis* per 0.25 ml suspended in Stainer-Scholte media, with 0.25 ml delivered per nostril. The bitch was not inoculated. Inoculation day

was considered day 1 for the study. Body weight, temperature, and rate of respiration were recorded daily for one week, and once per week thereafter (days 7, 14, 21, and 28). The nasal passages of the remaining pups were swabbed using calcinate alginate swabs (Fisher Scientific) with a 1% solution of Casamino acids (Sigma Chem. Co.) as transport media on days 1, 2, 4, 7, 14, 21, and 28. Swabs were cultured on both Bordet - Gengou (15% sheep blood, 100 µg/ml cephalexin) and MacConkey's agar. Blood (approximately 0.5 to 1ml) was drawn once weekly beginning at day one (days 7, 14, 21, and 28) from remaining pups for serum analysis. The bitch was bled and swabbed only on days one and 28. Bitch and pups were monitored for outward clinical signs of disease such as nasal discharge, coughing, or dyspnea. At 1, 2, 3 and 4 weeks post inoculation, two randomly chosen pups were euthanized and necropsy performed to look for internal signs of disease such as gross respiratory lesions. Week one - pups 18 and 22; week two - pups 17 and 19; week three - pups 20 and 21; week four - pup 23. Samples of tonsil, trachea, lung, and spleen were taken for bacterial culture, PCR (polymerase chain reaction) assay, and histologic analysis. Samples for histologic analysis were stored in neutral buffered formalin at room temperature until processing.

Culture Methods - Nasal swab plates were incubated at 37° C for a period of one to two weeks. Bordet - Gengou plates were modified after the first two swabbings from group one to contain 100 µg/ml of the antibiotic Cephalexin in order to discourage growth of normal flora. The Bordet - Gengou plates were examined for possible *B. pertussis* colonies, and the MacConkey's plates were examined for possible *B. bronchiseptica* colonies. All suspect *B. bronchiseptica* colonies found on MacConkey's plates were first tested with oxidase reagent, then any colony found to be oxidase positive was identified by means of a commercial API 20 E Identification System (bioMerieux Vitek, Inc.). None of the suspect organisms were *B. bronchiseptica* according to the API 20 E tests. Colonies from the Bordet - Gengou plates containing cephalexin which morphologically resembled

B. pertussis were also tested by oxidase and API 20 E , as well as being isolated and streaked on a plate of Charcoal agar (Oxoid) for examination of colonial morphology.

Following necropsy, the samples of tonsil, trachea, lung, and spleen were first swabbed using a calcinate alginate swab by searing the surface of the tissue and then breaking that surface with the swab. The swabs were then plated on both Bordet -Gengou media containing cephalexin and MacConkey's agar. Tissue swab plates were incubated at 37° C for a period of one to two weeks. Plates were analyzed using the methodology described above. Following swabbing, each organ was macerated and a small sample placed in a centrifuge tube for DNA extraction. The remainder of the tissue was placed in a freezer at approximately -20° C. To each tube containing macerated tissue, 200 µl of Instagene DNA Matrix (BioRad) were added and DNA was isolated according to manufacturer's instructions. The DNA was then used in Polymerase Chain Reaction (PCR).

PCR Methods - A modification of the procedure described in Lind-Brandberg was performed (9). PCR reaction mixes for each tissue were prepared using Ready-To-Go PCR Beads (Pharmacia) as follows: 5 µl of sample DNA, 17 µl sterile water, and 3 µl of premixed primer solution. The primer mixture consisted of 30 pmol of PIp1 (5'-CCCATAAGCATGCCCGATTGAC-3') and 15 pmol PIp2 (5'-CGCACAGTCGGCGCGGTGAC-3') (Genosys). The reaction mixture was then vortexed, pulsed in a centrifuge, and overlaid with 50 µl of sterile mineral oil. The tubes were then placed in a thermocycler (Hybaid Omnigene) for forty cycles of 30 sec. at 94° C followed by 2 min. 30 sec at 66° C. These forty cycles were then followed by 1 min. at 96° C, 1 min. at 50° C and 1 min. at 72° C . Control samples for both *B. bronchiseptica* and *B. pertussis* were prepared by resuspending dehydrated cultures in sterile saline, then extracting the DNA with the Instagene DNA Matrix. After PCR was complete, 10 µl of each sample was mixed on parafilm using a pipet with 6 µl of LT tracking dye and subjected to electrophoresis in a 1% agarose gel containing 10 µl ethidium bromide at 100

volts for approximately one hour. Gels were then visualized using a UV transluminator (Fotodyne).

ELISA Methods - Blood samples taken from both groups of pups as well as the bitch were treated identically. All samples were processed and frozen within several hours of bleeding. Each sample was first centrifuged for 10 min. at 1100 rpm in order to separate cellular material from the serum. The serum was then removed using a sterile pipet and each sample placed in a labeled 1 ml centrifuge tube and stored at -20 C until ELISA was performed. A commercially available human pertussis ELISA kit (Labsystems) was used to quantitate *B. pertussis* antibody titers. The provided human control sera were used as positive and negative controls as per manufacturer's instructions. Control wells used anti-human IgA as a conjugate. Sample wells were filled with a 1:100 solution of the respective samples. The kit instructions were followed precisely in respect to incubation times, washing procedures, and use of substrate. Following the first incubation and wash cycle, the provided human conjugate solution was added to the control wells, and a 1:500 solution of anti-dog IgG (Sigma Immunochemicals) was added to the sample wells. Both the human and canine conjugates were prepared according to the kit instructions, using the provided conjugate diluent. From this point, manufacturer's instructions were followed without deviation. Following the final incubation and addition of the 1N NaOH stop solution, the plates were read using the IDEXX Flockcheck program on an ELISA reader (Dynatech MR650) at 410 nm. Data was analyzed in accordance with manufacturer's instructions. A cut-off point for determining positive samples was calculated by statistical analysis of the absorbance levels. The mean of the prebleed samples (day 1) plus three standard deviations was used as this cut-off point. All samples greater than this number were considered positive.

Histopath Methods - Tissue samples obtained from the pups at necropsy were first cut to manageable size, the placed in a cartridge for processing and stored in neutral buffered formalin at room temperature. Samples were sent to Virginia - Maryland

Regional College of Veterinary Medicine teaching hospital, Histology Laboratory (Blacksburg, Va.) for processing.

The slides were then examined and each individual organ critiqued for indications of a subclinical infection. A lesion score system was used to categorize the severity of any lesions, a score of one being slight, two being moderate, and three being severe. The tonsils were inspected for signs of lymphoid hyperplasia and epithelial lymphoid effacement in both the crypt and the external surface. Lung tissue was examined for alveolar and airway inflammation, presence of macrophages and neutrophils, and overall appearance of the lungs. The trachea was examined for evidence of loss of mucosal cilia and inflammation. Spleens were inspected for abnormal development of perivascular follicles, size and number of monocyte islands, and evidence of hematopoiesis. A slightly modified scale was used for categorization of spleen lymphoid nodules. A five point system was used in which three was considered normal, four slight hyperplasia, five moderate to severe hyperplasia. A score of two denotes slight atrophy,and a score of one denotes moderate to severe atrophy. Spleens which exhibited an increase in the size and number of monocyte islands was denoted with a +mono, and hematopoiesis was indicated as either present or absent.

Results

Infection - At no time during the study did any of the test animals show any clinical signs of *B. pertussis* infection. Growth rates for all dogs were consistent over the course of the study, as were temperatures.

Culture - Nasal swabs cultured on MacConkey's agar showed no evidence of any *B. bronchiseptica* in any of the test animals. The most commonly found organism on the MacConkey's plates was *Eschericia coli*. Initial cultures on unmodified Bordet - Gengou agar (first week of the study) yielded lush lawns of normal flora which could have obscured any of the slower growing *B. pertussis* colonies.

After the addition of 100 μg/ml cephalexin to the agar, the problem of normal flora was remedied. At three weeks post infection, pup #19 produced a positive culture from nasal swab. The culture was confirmed to be *B. pertussis* by API 20E and culture on Charcoal agar (Oxoid).

ELISA - Results of the ELISA for group one pups is represented in Table 1. The only significant incidence of seroconversion was observed in the challenged pups (pups 9, 11, and 13). Pup #14 showed a peak at three weeks post inoculation, but at week four levels dropped back below the predetermined positive cut-off.

Table 1. Group One ELISA results.

	Week 1	Week 2	Week 3	Week 4
Pup 9	-	-	+	+
Pup 10	-	-	-	-
Pup 11	-	-	+	+
Pup 12	-	-	-	-
Pup 13	-	-	+	+
Pup 14	-	-	+	-
Pup 15	-	-	-	-
Pup 16	-	-	-	-

Results of the ELISA for group two pups is represented in Table 2. Only pup #23 may have seroconverted. Pup #20 shows a positive at two weeks post inoculation, but thereafter returns to prebleed levels. The bitch, which was bled on days 1 and 28, showed a remarkably high positive (higher than the positive control sera) at both time periods.

Table 2. Group Two ELISA results.

	Week 1	Week 2	Week 3	Week 4
Pup 17	-	-	X	X
Pup 18	-	X	X	X
Pup 19	-	-	X	X
Pup 20	-	+*	-	X
Pup 21	-	-	-	X
Pup 22	-	X	X	X
Pup 23	-	-	-	+
X denotes pups that had been necropsied.				

Polymerase Chain Reaction - In general, no *B. pertussis* DNA was recovered from the trachea or spleen of any of the pups from either group. Results of the PCR for group one is represented in Table 3. *B. pertussis* DNA was recovered only from the tonsils of pups 12, 14, and 15, all of which were contact exposed animals. Interestingly, no *B. pertussis* DNA was recovered from any of the three challenge pups.

Table 3. Group One PCR results.

	Tonsil	*Trachea*	*Lung*	*Spleen*
Pup 9*	-	-	-	-
Pup 10	-	-	-	-
Pup 11*	-	-	-	-
Pup 12	+	-	-	-
Pup 13*	-	-	-	-
Pup 14	+	-	-	-
Pup 15	+	-	-	-
Pup 16	-	-	-	-
	* Indicates Pup challenged on day one.			

Results of the PCR for group two pups is represented in Table 4. The week at which each pup was euthanized is indicated in the table. Again, the tonsils contained *B. pertussis* DNA for three of seven the pups in group two. Five of the seven pups (17, 18, 19, 20, and 21) contained *B. pertussis* DNA in their lungs as well. Pups 18 and 20 were positive for *B. pertussis* DNA in both the lungs and tonsils.

Table 4. Group Two PCR results.

	Tonsil	*Trachea*	*Lung*	*Spleen*	Necropsy
Pup 17	-	-	+	-	Week 2
Pup 18	+	-	+	-	Week 1
Pup 19	-	-	+	-	Week 2
Pup 20	+	-	+	-	Week 3
Pup 21	-	-	+	-	Week 3
Pup 22	+	-	-	-	Week 1
Pup 23	-	-	-	-	Week 4

Histopath Results

Group one : Nearly all of the pups in group one show some degree of tonsil infection in the form of lymphoid hyperplasia and lymphoid epithelial effacement. Pups 9 and 10 have minimal airway inflamation and pup 13 had a minimal alveolar inflamation. Group one spleen involvement was very minimal, with three of the eight pups showing minor lymphoid hyperplasia (only one of which was a challenge pup) and with only one of the eight pup showing evidence of minimal hematopoeisis. Tracheal activity was almost nonexistant, with only one pup in each group showing slight deciliation of the mucosal lining.

Table 5 : Group One Histopath Results

	Pup #9	Pup #10	Pup #11	Pup #12	Pup #13	Pup #14	Pup #15	Pup #16
Lung								
Airway inflamation	0.5	0.5	0	0	0	0	0	0
Alveolar inflamation	0	0	0	0	0.5	0	0	0
Tonsil								
Nodular Lymphoid Hyperplasia	2	2	3	2	1	2	2	3
Epithelial Lymphoid Effacement	2	1	2	2.5	1	1.5	1.5	1.5
Inflamation	0	0	1	0	0	0	0.5	0
Spleen								
Lymphoid Nodules	3	4	3	3	4	3	3	4
Red Pulp	0	0	0	0	0	0	0	0
Hematopoiesis	-	+	-	-	-	-	-	-
Trachea								
Mucosal Cilia Loss	0	0	0	0	1	0	0	0
Inflamation	0	0	0	0	0	0	0	0

Group Two : All group two pups showed some degree of tonsil infection in the form of lymphoid hyperplasia and lymphoid epithelial effacement. In group two, the lung involvement was more pronounced. Pups 21 and 23 show slight to moderate alveolar inflamation, with pup 23 having slight to moderate inflamation of the airways as well. Pup 21 showed minimal inflamation of the airways. Group two pups spleen results were characterized by normal to slightly underdeveloped lymphoid nodules and increased monocyte presence. All group two pups showed evidence of moderate hematopoeisis.

Table 6 : Group Two Histopath Results

	Pup #17	Pup #18	Pup #19	Pup #20	Pup #21	Pup #22	Pup #23
Lung							
Airway inflamation	0	0	0	0	0.5	0	1.5
Alveolar inflamation	0	0	0	0	1.5	0	1.5
Tonsil							
Nodular Lymphoid Hyperplasia	1	0.5	0.5	0.5	2	1	0.5
Epithelial Lymphoid Effacement	1	0.5	0	0.5	1	1	0.5
Inflamation	2	0	0	1.5	2	2	2
Spleen							
Lymphoid Nodules	3	2	3	3	3	2	3
Red Pulp	0	+ mono	+ mono	+ mono	+ mono	+ mono	0
Hematopoiesis	+	+	+	+	+	+	+
Trachea							
Mucosal Cilia Loss	0	0	0	0	0	1	0
Inflamation	0	0	0	0	0	0	0

Discussion

The potential ability of *Bordetella pertussis* to cause subclinical infections in both man and domestic animals would provide an intricate network by which the organism could be transmitted to unvaccinated children. Since a subclinical by definition is not diagnosable by external symptoms or standard detection methods, infected animals may be capable of transmitting the pathogen even though they appear outwardly healthy and normal. Given the severity of *B. pertussis* in unvaccinated humans, it is important to have a clear understanding of all possible infection pathways.

In the case of group one, three of eight pups were inoculated with *B. pertussis* on day one of the study and housed with the remaining five pups in order to determine whether an infection can be maintained in a pup and whether that pup can potentially transmit the infection to other pups exposed to it. The infections that were carried through in challenge pups 9, 11, and 13, as evidenced by ELISA, showed no clinical symptoms over the duration of the study. The fact that growth rate and temperature were apparently unaffected provides further evidence for the subclinical aspects of *B. pertussis* infection. These results were expected due to the lower dosage of *B. pertussis* used as compared with the larger dose given in the pilot study by Veit and Roop which did produce some clinical symptoms and lung lesioning (17). The study by Veit and Roop

additionally used a "double hit" method of inoculation which consisted of an intratracheal injection of 0.5 ml of 4 x 10^8 cfu/ml followed by an intranasal injection of 0.25 ml per naris of 1 x 10^9 cfu/ml two days later (17). The single inoculation and smaller dosage (5 x 10^6 cfu/ml) used in this study was intended to make the inoculation more representative of what a pup might encounter, since exposure would most likely come through a one time, brief encounter with an infected individual.

There was surprising difficulty in culturing the *B. pertussis* by intranasal swabbing, with only one successful culture obtained. This difficulty could be due to the small inoculum dosage combined with the problems inherent in culturing *B. pertussis*. *B. pertussis* is a notoriously slow grower and does not culture well on artificial media. In addition, the number of organisms present in the nasopharynx was probably too small for detection by nasopharyngial swab culture.

In group one inoculated dogs, seroconversion is witnessed beginning at three weeks post infection and continued until they were euthanized on day 28. No seroconversion was observed in the contact exposed animals, with the exception of a peak in pup 14 at three weeks. Since this level returned to pre-bleed levels the following week, this is probably not evidence of true seroconversion, as IgG levels typically maintain detectable levels for greater than one week. When compared with the PCR results, it appears that the inoculated dogs had cleared the *B. pertussis* to levels undetectable by gel electrophoresis by the fourth week. The study by Veit and Roop also found rapid clearance occurred at approximately the fourth week of infection (17). *B. pertussis* DNA was also detected in the tonsils of pups 12, 14, and 15, indicating that bacteria had actually been transferred from inoculated dogs to the control dogs. Since PCR only detects DNA, and no live cultures were obtained from the nasal or tissue swabs, it is impossible to determine the viability of the *B. pertussis* in the tonsils. However, the fact that DNA was detected is significant since it suggests that *B. pertussis* had infected the inoculated dogs in sufficient number to be transferred via the aerosol pathway to other animals in contact

with them. The fact that pups 12, 14, and 15 showed no seroconversion, but showed a positive PCR in their tonsils, may represent a lag in infection time: the time it took for the infections in the contact exposed dogs to multiply to sufficient numbers to stimulate a detectable antibody response. The contact exposed pups were probably infected at some point prior to the seroconversion of the inoculated pups, and the inoculation was probably at a much lower concentration than what was given to the inoculated dogs. This may explain the lack of seroconversion in these pups. Had the study been allowed to go for six rather than four weeks, seroconversion may have occurred in pups 12, 14, and 15. Another possibility is that the number of organisms maintained in the body was insufficient to cause a significant stimulation of antibody production.

Transmission does seem to occur in extremely limited instances. None of the contact exposed pups showed signs of seroconversion, but pups 12, 14, and 15 had detectable amounts of *B. pertussis* DNA present in their tonsils at four weeks post inoculation of pups 9, 11, and 13. Histopathologic data correlates with the PCR data in that pups 12, 14, and 15 all show slight to moderate slight to moderate tonsilar lymphoid hyperplasia and moderate to severe epithelial lymphoid effacement. It remains unseen as to whether these contact exposed dogs can transmit *B. pertussis* to animals exposed to them or to humans. This information would make a much more convincing argument for transmission.

The second experiment attempted to determine the locations at which *B. pertussis* would colonize during the course of an infection. According to the PCR results, the only significant colonization seems to be localized to the tonsils and lungs. These results do not seem to indicate any recognizable progression during the course of the infection. Since both dogs necropsied at week one showed *B. pertussis* DNA in their tonsils, this may indicate that the tonsils to be the initial infection site. The lungs, however, provided *B. pertussis* DNA most often in the group two pups. Since this was not the case in group

one pups, it could indicate that infection is a function of age of the pups. It is impossible to determine this from the data obtained.

The lack of seroconversion in the group two pups is believed to be a result of the development of the pups' immune systems due to the young age of the pups. Only pup 23 showed significant seroconversion during the fourth week of the study. Pup 20 showed a peak at two weeks post inoculation, but then dropped back to pre-bleed levels and is therefore most likely not a true positive titer for IgG levels.

The histopathologic analysis indicates the points of infection to be primarily restricted to the tonsils and lungs, with the trachea playing only a very minor role. In both groups tonsilar epithelial lymphoid effacement and lymphoid hyperplasia were exhibited in almost every dog to varying degrees. The breakdown of epithelium by adjacent hyperplastic lymphoid nodules could be in response to a bacterial pathogen attaching to the surface of the epithelium or trapped in the tonsilar crypt. This data correlates with the PCR data in that all pups which had detectable *B. pertussis* DNA in their tonsils showed moderate to severe lymphoid hyperplasia and epithelial lymphoid effacement. Since PCR data indicates the tonsils to be a site where *B. pertussis* localizes, it is very likely that the conditions observed in these tissue samples are the result of a mild *B. pertussis* infection.

More subtle signs of mild respiratory infection are seen in a few lung samples from each group. Pups 9 and 10 in group one showed some minimal inflammation of the airways, indicated by the presence of macrophages and neutrophils in pus collected inside several of the airways. Pup 13 had a minimal inflammation of the alveoli as well. These very minor inflammations are most likely resultant of the *B. pertussis* infection although PCR did not detect any *B. pertussis* DNA in any lung samples from group one dogs. The lack of detectable *B. pertussis* DNA in the lungs is probably due to the small number of organisms associated with a subclinical infection. Had the infection taken hold to the point of clinical manifestations, far greater lung lesioning would have been expected. The lung manifestations in the group two pups was more severe, most likely due to the

younger ages of the pups. Pups 21 and 23 showed slight to moderate inflammation of the bronchioles and alveoli. Still, had the infection taken hold, the lung inflammation would have been much greater.

The trachea seems to be of relative unimportance in these subclinical infections. Only one pup in each group showed minimal mucosal deciliation that could be resultant of a *B. pertussis* infection. *B. pertussis* acts by attaching to the ciliated epithelium of the respiratory tract. This can lead to irritation of the cells and the shedding of cilia. In the pups that showed some cilia loss, the vast majority of the epithelium appeared normal and healthy. Only a few small areas appeared to show an irritation of the epithelium.

The spleen seems to play little, if any, role in a canine subclinical *B. pertussis* infection. All spleens in group one pups appeared very similar, with only slight variation in size of perivascular follicles and little hematopoiesis. Group two pups' spleens also appeared very similar. They were characterized by an increase in monocyte count and hematopoiesis. This difference between the two groups is most likely a function of age differences. The hematopoiesis seen in the group two pups is probably due to the increased demand for red blood cell production required by a young, rapidly growing dog.

Overall, the data seems to indicate that pups who encounter a significant dose of *B. pertussis* are capable of maintaining a viable stock of bacteria for a period of up to four weeks. At doses which a pup is likely to encounter, the infection would remain subclinical and the pup would show no outward signs of disease. Even if suspected, diagnosis by conventional methods would be difficult due to the low number of bacteria present in such an infection. Diagnosis by ELISA would also be somewhat ineffective since there is no antibody differentiation of the *Bordetella* species and many dogs are likely to encounter *B. bronchiseptica*. PCR seems to be the most accurate of the ways tested of diagnosing a subclinical *B. pertussis* infection in non-primate animals. The PCR technique might be improved by coupling it with Southern blotting techniques or fluorescent antibody tags to make the DNA bands more distinct.

Subclinical *B. pertussis* infections appear to localize to the greatest extent in the tonsilar crypts, where the bacteria can remain for up to four weeks. Viable *B. pertussis* bacteria were recovered by nasopharyngeal swabbing of pup 19 at three weeks post infection, indicating that the bacteria can remain viable for at least three weeks in a canine host. The lungs also seem to play a role in these subclinical *B. pertussis* infections. The *B. pertussis* DNA remained detectable by PCR through four weeks post inoculation in group two pups. Additionally, *B. pertussis* DNA was still detectable in the tonsils of three of the group one pups at four weeks post inoculation. There does not, however, seem to be a clear pattern of localization over the course of an infection. PCR analysis of group two dogs shows that both the tonsils and the lungs had detectable amounts of *B. pertussis* DNA up until four weeks post inoculation, at which time none of the tissues sampled had detectable amounts of *B. pertussis* DNA. This suggests that infection of both the tonsils and lungs occur within the first week and both maintain infection up to four weeks.

This study was extremely limited in both time and resources. Only two small litters of pups were used for this study. This may not be an accurate representative sampling and more precise results could probably be obtained by conducting similar studies with much larger groups of animals. Culturing and detection methods were also rather limited. There was difficulty culturing the bacteria on the media which we used. *B. pertussis* is naturally a slow grower and difficult to culture on artificial media. Supplementation of the standard media with 100 μg/ml cephalexin in order to suppress the growth of normal flora may also have slowed the growth of *B. pertussis* to some extent.

Despite its limitations, this study hints at the possibility of subclinical infections of domestic animals playing a role in the transmission of *B. pertussis* to humans. Future studies would be warranted to gain a greater understanding of the nature of these infections and whether they occur in a natural setting. These studies should utilize a larger group of subject animals to get a more accurate picture of how the infection affects the animals. The inoculum dosage should be again lowered to a more realistic number of

organisms that an animal may possibly encounter in a natural setting. Also, similar studies should be performed on other types of domestic animals such as cats, pigs, domestic birds, and so on. Studies such as these could help broaden the scope of the concept of subclinical non-primate *B. pertussis* infections.

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