JEFFREY BENNETT: Hi, I'm Jeffrey Bennett. I'm an optometrist here at the Mayo Clinic in the Department of Ophthalmology. And I'm here today to talk about my research in visual memory, recall, and sports related concussion. I'll start by giving some background information on sports related concussion.

According to the Centers for Disease Control and Prevention, incidents of sports related concussion ranges from approximately 300,000 to 3.8 million each year in the United States. The millions of athletes participating in collision sports like football are most likely to suffer concussion. 1.8 million Americans play football. The majority are in high school. Estimates of football related concussion can be expressed as a ratio of number of concussions per 1,000 athletic exposures.

In high school and college football, an athletic exposure is one player participating in one practice or a game. The National Football League does not include practices in their data, only games. The incidences of sports related concussion may be higher, however, due to underreporting of on-field concussion signs and symptoms. Signs of an athlete's concussion can be overlooked by sideline medical personnel, coaching staff, or teammates. Athletes with concussions sometimes fail to report their symptoms.

A 2004 study survey 229 high school football players who were concussed while playing during the season. Over half of these concussed football players did not report their symptoms to medical personnel. And of these players, 41% did not want to leave the game, and 22% did not want to let their teammates down. Of course these players are putting their own health and well-being at risk by not reporting their symptoms, and they are probably a liability to their entire team when they remain in a game.

Can these concussed players remember their plays or formations? Would a concussed offensive lineman not remember a blocking assignment, and put his running back at risk for injury? And could a test be designed to identify concussed players by testing their memory and recall of plays? The tachistoscope was developed over 80 years ago. Initially, it was used to test intelligence by measuring a subject's ability to recall an 8 to 12 digit number after it was shown just for tenths of a second.

So in the first modern tachistoscope, flash cards are stored in the hopper, a card then falls down a slide, and it is shown for tenths of a second to the subject. The tachistoscope tests visual memory, visual processing speed, attention, and recall of a visual pattern. Any image can be used a visual stimuli. For example, during World War II, allied fighter pilots were trained to distinguish between allied and axis planes using a tachistoscope

In the research presented in this video, we used a tachistoscope to test visual memory and recall in football players concussed during practices or games. In a survey of 150 coaching education students, almost 85% of the student coaches would remove their player and get medical staff consultation if he forgot his play assignment following impact to the head. Our tachistoscope is an iPad app. We designed an iPad tachistoscope application that would use football plays unique to an individual team as the images to test visual memory and recall. Then we determined if players could still identify their plays after being concussed during play.

Our tests consist of 12 randomized flash cards. They're shown for approximately 0.6 seconds. And following the visual image being shown randomized multiple choice of four descriptions of the flashcard are displayed for 4 seconds. And a total score is number correct out of 12. Our initial study determined the test retest correlation of the tachistoscope on 58 healthy subjects.

These subjects included a girls high school volleyball team using setting plays of visual images, a boys school hockey team using hockey images, opticians and optometrists testing visual memory recall of tools and instruments, and restaurant wait staff on their new menu items that they were required to learn. So we were please find in correlation coefficient of 0.72 and move the study on to testing concussed football players. The research began with collaboration with the University of Wisconsin Lacrosse Athletic Department starting with the 2013 football season. 57 returning football players were divided into three groups by position, defense, quarterbacks, wide receivers, and the third offensive lineman, running backs, and tight ends.

A test was created for each position group. 12 images in all were tested. Five were football formations and plays chosen by the head coach for each position group. The remaining seven were football helmets of the UW lacrosse conference foes. A baseline test was performed on each player the day before the first practice.

The protocol was when a player suspected of being concussed during practice or a game was removed, the head athletic trainer performed a sideline concussion test as usual. After these tests the concussed player would take the position group's tachistoscope test. For each player removed from play for suspected concussion, an uninjured teammate of the same position would take the test as a normal match. During the 2013 season, seven players were diagnosed with concussion during practices or games. This table shows the concussed players uninjured baseline scores with their concussed sidelined scores.

Both test scores are similar. Any differences in the scores are not statistically significant with a p-value of 0.45. This table compares the sideline scores of the concussed players with their uninjured match. There is not a statistical difference between concussed and normal sideline scores.

What can we conclude from the 2013 results? Was it these seven concussed players not have diminished visual memory and recall of their plays? Or was the test too easy? Do we need to replace helmets with additional plays in formation, or make the test faster?

So our study is continuing into the 2014 UW lacrosse football season. And we've modified the test. The test now consists of 12 plays and formations for each position group. We cut the speed the same.

This is a more difficult test of memory and recall. And the preseason baseline scores for all position groups were lower than in 2013. Early 2014 data with two concussive defensive players show a greater decline in scores from baseline to sideline, but more subjects need to be tested.

Once again I'm Jeffrey Bennett with the Ophthalmology Department at the Mayo Clinic, and thank you for listening.