The importance of vision in motor control psychology essay

Many people do not realize how much we use our vision for more than just actual sight. Several of our own personal experiences as well as research evidence tells us that vision not only plays a crucial role in allowing a person to see the environment; but it becomes the most reliant of the sensory system (Bear et. al., 2001). From the basic anatomy of the eye, to the various motor control functions that our bodies engage in daily, these skills happen from a first person perspective subconsciously. Visual information is important for performing an array of motor skills. Especially when a performer's movement must coincide with a changing environment; such as, catching a ball or in motor performances, requiring precision and exact movements of the hand to a designated target. For many, trying new activities such as learning to play the piano or learning to type on the keyboard can be difficult without looking at where your fingers touch. Ultimately, vision affects performance, accuracy and efficiency of a skill. These kinds of past subjective experiences illustrate our tendency to give vision a predominant role when performing motor tasks and skills.

How the eye functions is as simple as one can blink. Vision is the process in which sensory receptors of the eyes are receiving and transmitting wavelengths of light to the visual cortex of the brain by way of sensory neurons known as the optic nerve. " The eye acts like a camera, forming crisp, clear images of the world" (Bear et al., 2001). Like a camera, the eye automatically adjusts differences in light and dark as well as focusing itself on objects of interest. So how do two human-like cameras contribute to our daily motor activities? Not only are we visually processing information constantly, but also the information being processed is sending signals to the central nervous system and in turn reacts with the information from the environment and the proprioreceptors. The eye can still do much more than a camera such as, track moving objects and the ability to keep its transparent surfaces clean. The basic anatomy of the eye includes the cornea, pupil, iris, lens, and retina. These all play important roles in the function of vision. The cornea serves as an important part of the eye's optical system; the pupil is the opening in the eye that lets in light automatically adjusting to the amount of light detected by the eye. The iris is the structure that surrounds the pupil and provides the color, whereas the lens is the transparent eye structure that sits behind the iris and allows the eye to focus at various distances. Lastly, the retina lines the back wall of the eye and works as an extension of the brain, containing the neuroreceptors that transmit the visual information to the brain.

The study of vision and motor control by Woodworth dates as far back as 1899. Woodworth was interested to see how movement speed affected and influenced movement accuracy. This was important because he realized spatial accuracy was partially a function of visual feedback received during movements. Woodworth sought to determine the shortest movement time where vision facilitated movement accuracy of the motor performance. He hypothesized that shorter durations of movement time, whether eyes were open, were not as accurate than with eyes closed. As the average time for successive attempts for each movement increased, spatial errors decreased when the eyes were open but remained relatively constant when the eyes were closed. Woodworth concluded, from his methods, that the time to process visual feedback for the control of movement was about 450 ms.

The dominance of vision can stimulate the brain even when presented with an artificial limb or appendage. A neuroimaging study by Ehrsson (2004) provided evidence of the brain activity that underlies a perceptual illusion known as the “ rubber hand illusion”. This illusion relates to the normal feeling of having and differentiating our own limbs and when we manipulate them or external objects. The illusion consists of a person sitting at a table while looking at a realistic life-size rubber hand on the table. The person’s own hand out of view. The experimenter uses two small paintbrushes to simultaneously brush the person’s hand and the rubber hand, to acknowledge the importance of synchronized brushing. After multiple brushings, the person begins to believe they can feel the brush strokes on the rubber hand as if it were his or her own hand. Many of the participants actually reported that the rubber hand felt like their own. Botvinick and Cohen (1998) showed that this illusion of the fake rubber hand is a distortion of proprioceptive information in the brain. This is significant because it helps us understand the pairing of the visual observation of the brushing of the rubber hand with the propriocetive sensation of touch through brushing on the real hand resulting in a perception that the visually observed rubber hand is part of the person. This study by Ehrsson, showed activation in the prefrontal cortex, suggesting that, the mechanism responsible for the feeling of the rubber hand is a feature of this area of the brain.

More evidence suggests the importance of vision and motor control. The “ moving room” experiment by Lee and Aronson (1974) consisted of participants standing in a room in which the walls could move up or down, as well as forward or backward. Although the walls moved, the participant remained stationary on the floor. This shows a conflict of sensory information happened and the person's vision signaled that they were moving but the rest of their body told them they were standing still. Other factors that contributed to this sensory information conflict were tau and optic flow. Lee and Aronson (1974) observed postural responses to the movement of the walls. When the walls were in motion, both children and adults moved to make posture correction adjustments trying to maintain their balance in perspective of the floor and moving walls. However, because the floor was not moving their proprioceptors were not indicating that their bodies were losing stability. The moving room experiment demonstrates the special priority we assign to vision in our daily activities. When proprioceptiors and vision provided conflicting information to the central nervous system, people gave attention to vision while ignoring the proprioceptors. The result was that they initiated unnecessary postural adjustments.

Many researchers use a variety of techniques to study the role of vision in motor control. The most direct technique involves the recording of eye movements as a person performs a task. Other techniques may provide indirect ways to determine how a person uses vision during the performance of a skill. The recording of people's eyes require specific equipment that is used to record and keep track of where the eyes are looking at a particular time. This equipment becomes a tool to record foveal displacement of the participant during the performance of the skill specifically at any time interval, as well as the place and length of time the person fixates their eyes at that certain location. An experiment by Williams (2002) eye movement recording is used to examine the role of vision in the performance of a motor skill. This experiment compared professional and amateur tennis players as they viewed and responded to action sequences that would occur in a tennis match. They viewed the perspective of the opponent positioned midcourt on the other side of the net. The videos displayed opponents hitting forehand and backhand shots during a match play situation toward the player's left court, right court, center fore court, and center back court. The participants were then asked to wear eye movement monitors and asked to respond to each shot as they would realistically in a live play match. The results showed that the skilled players spent more time viewing the opponent's trunk-hip and heal-shoulder areas while the less skilled players focused on the opponent's racquet.

Central and peripheral vision have been examined by researchers in investigating the roles in motor control. Foveal vision detects information only in the middle two to five degrees of the visual field, while peripheral vision detects information in the visual field outside these limits. For most people, the visual field reaches approximately 200 degrees horizontally and 160 degrees vertically. A study done by Sivak & MacKenzie (1990), displayed that peripheral vision provides the central nervous system with information about the environmental context and the moving limb. When participants were restricted to using central vision to reach and grasp an object, the organization and control of the movement was affected, but not grasping of the object. When central vision was blocked and participants only had peripheral vision to rely on, the trials proved to be problematic in which they displayed impairment during the transport and grasping phases of the action. The results from this study show the distinct roles of central and peripheral vision in the control of limb movements. Especially those involved in manual aiming and prehension. Central and peripheral vision also plays a role in locomotion. Evidence has shown that central vision provides information that guides us so we can stay on a pathway; peripheral vision is important as it provides and updates our knowledge about the spatial features of the walking environment such as pathway drop offs or bumps (Turano et. al., 2005). Peripheral vision detects visual cues in the environment by analyzing optical flow patterns. Optical flow is important because it is a dynamic function of incoming information that allows for locomotion through an environment and achieve action goals.

Conclusively, touch, proprioception, and vision are important sources of feedback involved in movement control. Of these elements, vision is the most trusted and is important for enabling people to carry out their daily living and recreational activities. Research evidence established that vision plays numerous vital roles in motor control such as providing depth perception for interaction in our daily environment. It provides information that enables us to identify objects, people, and other environmental context components. With this information, vision also allows us to move through an environment simultaneously coordinating movements involved in eye-hand coordination activities and making dynamic movement corrections. It is essential to determine how deficits in any of these sensory systems may explain difficulties a person may have performing a specific activity. Movement coordination and accuracy problems may be the result of sensory-related problems. It is crucial to further extend our grasp of knowledge in the understanding of the function of vision in motor control.