The Tickle

How do motor commands influence sensory feedback during motor control?

Most people have spots on their bodies that are highly sensitive and respond to the external stimulation of tickling. Some people laugh and giggle; others find it irritating. But, why is it that we can't tickle ourselves? Go ahead and try it. Why do you not get the same response when you do it that you get when someone else does it?

Here is another curiosity. Use the tip of your index finger and gently nudge your eyeball by pushing lightly against the skin at the corner of the eye. What you will probably see is that the visual world jumps around when your eyeball is nudged; vision is blurred, and fixating on any one target becomes difficult. Now, instead of moving your eyeball with your finger, just quickly dart your eyes around, stopping very briefly to fixate on something. Notice that, in this case, your vision was not blurred.

Both of the preceding examples are classic demonstrations of an important capability of the central nervous system to interpret sensation. These examples demonstrate the capability for feedback cancellation (or, perhaps more precisely, feedback attenuation). *Feedback* refers the sensory information that arises as the result of movement. In some cases that sensory information has arisen because of something that we have done ourselves, and in other cases, it has arisen because of some other source. In all cases the attenuation of feedback occurs when we are expecting something specific to happen. For example, the sensation of a sudden and rapid acceleration in a car is not the same for the driver as it is for an unsuspecting passenger. For the driver, the rapid acceleration is a predictable result of having just pressed down hard on the accelerator. For the unaware passenger, however, who does not have such predictive knowledge of the change in the speed of the car, the sensation that arises from the feedback information is greatly heightened. Being prepared for a sensation that is about to occur changes how we experience that sensation once it does occur.

One of the remarkable features of our motor control system is the capability to predict the results of our intentions—in terms of both the expected outcome of our actions and the exact feedback sensations. This is not something that we have to try to do; it is a natural consequence of actively moving about in our environment. Sensory awareness is reduced, or attenuated, when the actual sensations match the predicted sensations. Perhaps this attenuation process is a way for the body to reduce the amount

From T.D. Lee, 2011, *Motor control in everyday actions* (Champaign, IL: Human Kinetics).

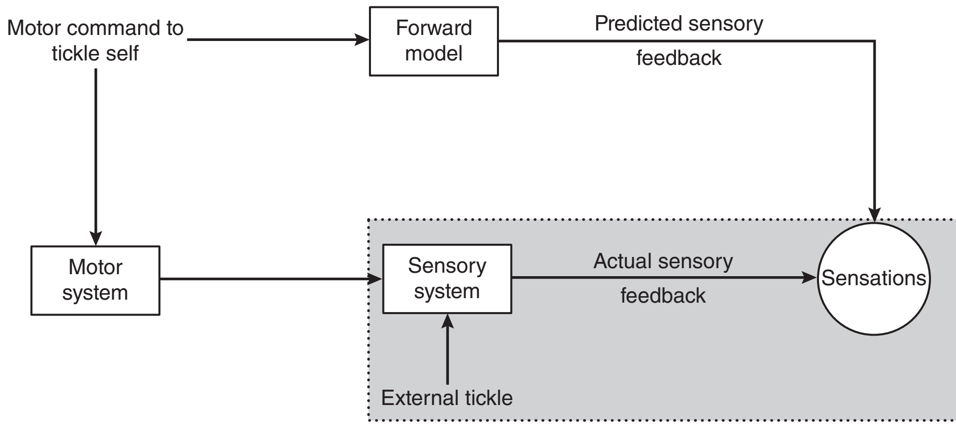

Figure 7.3 A model of sensations arising from self- and external tickles.

of sensory information we would have to deal with if everything that occurred as the result of our actions were completely unpredicted.

A model of the processes involved in tickling is presented in figure 7.3. According to researchers such as Sarah Blakemore, the process of trying to tickle yourself produces a set of anticipated signals that would be expected to arise from our skin receptors via the peripheral nervous system. Those signals change how we interpret the actual signals, drastically altering the tickling sensation. In contrast, the section of figure 7.3 highlighted in gray illustrates what happens when someone else tickles us. In this case, the absence of self-generated motor commands allows us to experience the sensation of the tickle without the attenuation of expected sensory feedback.

Of considerable interest, however, is that Blakemore and her colleagues found that the ticklish feeling can be partially reestablished if a temporal delay is inserted between your motor commands to tickle and the sensation arising from those motor commands. To do this, the researchers used a robotic "tickle machine" that provided the tickles after varying delays. In relation to the components illustrated in figure 7.3, the fidelity of the expected sensory feedback has been reduced by the time shift between the motor commands and the actual feedback. In other words, the feedback attenuation effect may depend on those sensory signals being received in a timely manner.

SELF-DIRECTED LEARNING ACTIVITIES

1. Define the term *feedback attenuation* in your own words.
2. Explain how the examples of pushing on your eyeball and trying to tickle yourself relate to the model presented in figure 7.3.
3. How does the sensation of a needle injected into your arm relate to the model presented in figure 7.3?

From T.D. Lee, 2011, *Motor control in everyday actions* (Champaign, IL: Human Kinetics).

4. Blakemore and colleagues used a self-controlled tickling machine (a robotic device) to control the time interval between the motor command to tickle and the response made by the machine. Describe a modification to this experimental technique that would help you understand more about the experience of tickling sensations.

NOTES

- Much of our current knowledge about forward models of movement control arose from the early work of Hermann von Helmholtz. This is a good starting point for more on this important researcher:
  http://plato.stanford.edu/entries/hermann-helmholtz/

SUGGESTED READINGS

Blakemore, S.-J., Wolpert, D.M., & Frith, C.D. (1998). Central cancellation of self-produced tickle sensation. *Nature Neuroscience, 1,* 635-640.

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Wolpert, D.M., & Flanagan, J.R. (2001). Motor prediction. *Current Biology, 11*, R729-R732.