Visual feedback enhances activation of muscle movement in response to bodily sensation

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Visual feedback is just as important as a sense of body position when it comes to the involuntary reflexes that activate muscle movement, says a new study in the open-access journal *eLife*.

The findings provide insights into how the brain balances different types of sensory information to control the earliest stages of movement, adding to our understanding of how these processes are controlled in health and disease.

Throughout daily life, we alter our body movements in response to changing cues. For example, when reaching for a target object our brain uses visual information about where the object is, as well as information about our current body position and self-movement. This information changes constantly and quickly, and so there is a continuous, sophisticated feedback loop where the brain converts the information into the correct and precise muscle response. A key component of this feedback is the 'stretch reflex' of muscle, which occurs milliseconds before the actual voluntary muscle movement.

"Several studies have suggested that the brain integrates multiple types of sensory information to achieve voluntary muscle control," explains lead author Sho Ito, a researcher at NTT Communication Sciences Laboratories, Kanagawa, Japan. "However, it is not known whether control of the initial stretch reflex is calculated from multiple sensory sources or from a single source, such as visual information. In this study we examined how altering visual cues, such as distorting or eliminating this information, affected the intensity of muscle stretch reflexes."

The team conducted experiments with people who were asked to move a cursor towards a visual target. In the first experiment, the movement of the cursor was changed, distorting the visual feedback participants received. The researchers calculated the effect of this change in visual cursor feedback on muscle stretch reflex by mechanically measuring muscle activity at the wrist. They found that by introducing a discrepancy between the actual hand movement and the movement of the cursor on the screen, the strength of the muscle stretch reflex was reduced.

Next, they compared muscle stretch reflex when people received normal visual feedback on how the cursor was moving versus receiving a mirror-reversed version of how the cursor moved. In half of the trials, the cursor was made to disappear entirely during the task. Both the distortion and removal of the cursor contributed to changes in the muscle stretch reflex. Removal of the cursor reduced the intensity of the stretch reflex, suggesting that being able to see the cursor is important for sufficiently activating movement correction. Moreover, the longer the participants

were unable to see the cursor, the lower the intensity of the stretch reflex and the greater the overall variability in people's movements. This suggests that being certain of our limb positioning is important in regulating the stretch reflex.

In the final experiment, the researchers looked at whether processing of visual information to coordinate muscle movement is always accompanied by a reduction in the muscle stretch reflex. For this, participants had to move the cursor towards the target again, but this time the target jumped around. This allowed the team to measure reflexes in the processing of visual information as well as the muscle stretch reflexes previously calculated. They found that the decrease in intensity of the muscle stretch reflex occurred only when distortion was introduced in the visual feedback, but not by a distorted map between visual target and motor action.

"Our study suggests that in the absence of clear visual cues, participants feel unsure of their own hand position, which reduces muscle stretch reflex and prevents an inaccurate or inappropriate movement," concludes senior author Hiroaki Gomi, Senior Distinguished Researcher and Group Leader at NTT Communication Sciences Laboratories. "The results show that feedback responses that control movement are calculated by the brain not from a single signal, but from multiple sources of sensory information including our vision, posture and sense of self-movement."

More information: Sho Ito et al, Visually-updated hand state estimates modulate the proprioceptive reflex independently of motor task requirements, *eLife* (2020). DOI: 10.7554/eLife.52380

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