Localization of touch on a replanted or transplanted hand: evidence for late improvements that may reflect central adaptations

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Former amputees that have received replantation of their injured hands (heterotopic hand replants), or transplantation of a donor hand (allogeneic hand transplants) provide an unique opportunity to evaluate the extent to which the effects of deafferentation can be reversed. Following sensory nerve transection and repair, peripheral nerve regeneration is estimated to proceed at a rate of up to 2mm per day, which would suggest full peripheral recovery in less than 1 year. However, human patients with surgical nerve repair of the arm or hand show persistent difficulties in localization of touch without vision. This may arise from persistent chronic disorganization of finger maps within the primary sensory (S1), as suggested by studies in nonhuman primates. Here, we tested the hypothesis that central adaptations associated with chronic experience can mitigate these functional limitations in right-handed heterotopic replant (N = 4) and allogeneic hand transplant recipients (N = 3).

We measured participants’ somatosensory localization accuracy by touching the participant’s hand, and asking the participant to indicate the touched point, in the absence of visual information of the initial touch or their response accuracy. On average, healthy adults localize touch with a very high level of precision, and exhibit no differences between left and right hands, (Right: Mean ± SD=4.00 ± 3.76, Left: 3.70 ± 3.40). Patients showed substantial variability (Affected Hand: 26.03 ± 24.75, Unaffected Hand: 4.77 ± 5.16), and a positive correlation between localization accuracy and time since hand replantation or transplantation. Two complete hand transplant recipients (8 and 10 years post-surgery) one mid-palm replant recipient (3 years post-surgery), and one full hand replant recipient (1.5 years post-surgery) exhibited the ability to localize stimuli on average within 95% confidence intervals of the control group on their affected hands.

Our findings suggest that the ability to localize touch may continue to improve for years following peripheral nerve repair and regeneration. This suggests that central experience-dependent adaptations play a role in recovery of function.