Directional encoding of force stimuli by human tactile afferents at fingertips

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When we use our digits in manipulatory tasks, we generate time varying fingertip forces in various directions. In this study we analyze how tactile afferents of the distal phalanges encode such fingertip forces. We used microneurography to record signals in single tactile afferents of digits II-IV. We applied forces to a standard site at the fingertip under three-dimensional force control. A flat surface contacted the fingertip. In addition to force stimuli normal to the skin, we delivered stimuli that included a tangential force component in the distal, ulnar, proximal and radial directions. Directional sensitivity of individual afferents was analyzed for stimuli with tangential force components both along the proximal-distal axis and along the ulnar-radial axis.
We recorded signals in 114 slowly adapting afferents (73 SAI and 41 SAII) and 82 rapidly adapting afferents (72 FAI and 10 FAII). The direction of force influenced the responses in most SA I (97%), SAII (82%) and FAI (76%) afferents, and in a minority of FAII afferents (40%). The majority of directionally sensitive SA I, SAII and FAI afferents increased their response with increasing tangential force in one of two opposite directions, but some 20% increased their discharge rates regardless of direction.
In conclusion: The responses in most SAI, SAII and FAI afferents of the distal phalanges are influenced by the direction of fingertip forces that occur in manipulative tasks. Individual afferents of each type can show different sensitivity patterns, but the patterns that dominate differs among the various types. The directional preference of the afferent was in some instances related to the location of its receptive field on the phalanx.